FOOD TECHNOLOGY

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FIFTEENTH ANNUAL MEETING
June 12-16, 1955
Columbus
Ohio

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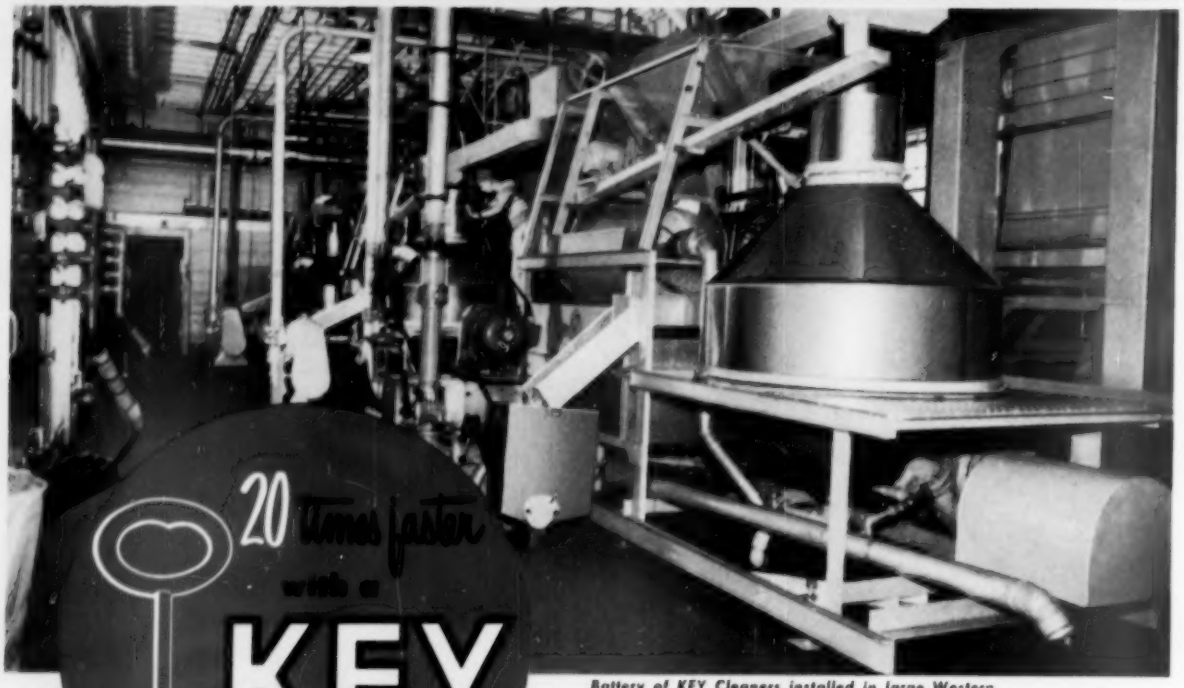
April, 1955 Volume 9, Number 4

SAVE MANPOWER—CUT CLEANING COSTS



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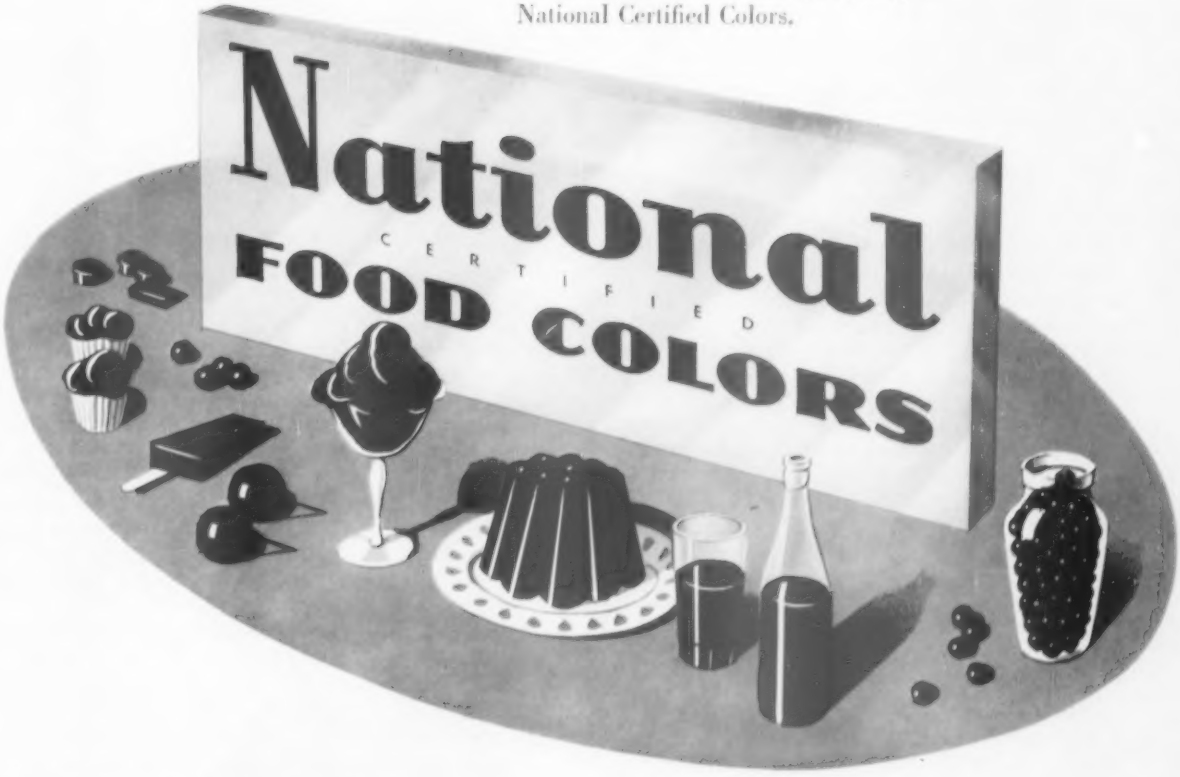

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Affairs of the Institute

Babcock-Hart Award Winner for 1955
Annual Meeting Bulletin Board
Nominees for President-Elect, 1955
Regional Section News
Books
Selected Abstracts
Recently Elected Members of IFT
Food Industry Topics
Future Meetings

Babcock-Hart Award Winner for 1955 Is Dr. William V. Cruess

Pioneer food technologist and former IFT president, Dr. William V. Cruess has received the distinguished Babcock-Hart Award, given each year to one who has advanced human nutrition by his achievements in food research or technology. The award, which carries with it an honorarium of one thousand dollars, was established in 1948 by the Nutrition Foundation, Inc. to honor Stephen M. Babcock. In 1954, the name of Edwin Bret Hart, another great figure in the quest for answers to profound nutritional problems, was conjoined with that of Babcock.

Dr. Cruess, early prominent in food science and technology on the West Coast, had attained national stature in his chosen field by 1930. His influence on the growth of the fruit dehydration industry has been not only deep but extensive, crossing national borders to stimulate the rise and growth of the industry in other lands. His introduction of the air blast tunnel with instrument control of humidity and temperature is one of the landmarks in the progress of food engineering.

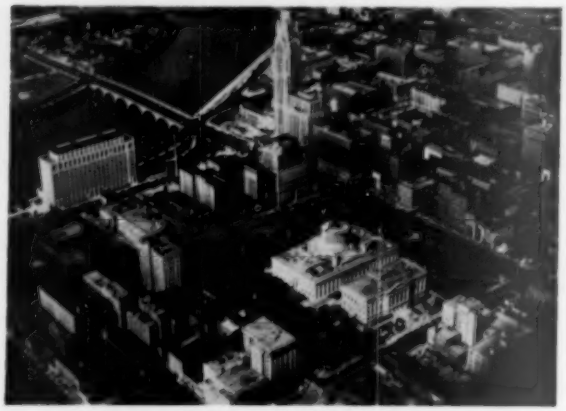
William V. Cruess was born in San Miguel, California—a native son with native son forebears extending back to the era of the Forty-Niners. His academic career began with his graduation from the University of California in 1911 and his election to a faculty position, as a fermentologist—a comparately new field—shortly thereafter. He has been a productive research worker from the beginning as the numerous articles, circulars, bulletins and books that derive from his experimentation will attest. He has been equally active as an educator, establishing one of the first, if not *the* first food technology course ever offered at the college level. The division of food technology, established in 1935 with Dr. Cruess as first chairman, evolved from the solid planning and substantial curriculum developed by Professor Cruess and his colleagues. A former student, Dr. Emil Mrak, who succeeded to the post of chairman when Dr. Cruess retired from administrative duties in 1948, has said of him, "The work of Dr. Cruess has had a tremendous effect on the horticultural products industry." Among these products are the wines of California, olives, citrus juices, Italian prunes, and a long list of vegetable products.

In selecting William V. Cruess for the 1955 Babcock-Hart Award, the jury of nine—appointed to the task by the president of the Institute—signalizes a life of devotion to the cause of improving and increasing the food supply of the nation. No small part of his contribution to the progress of food technology and science has been that of training young men and women to carry forward the immensely important programs initiated or stimulated by this pioneer in food technology.

Annual Meeting Bulletin Board

COLUMBUS, OHIO — JUNE 12-16, 1955

IFT members who fly into Columbus next June for the Fifteenth Annual Meeting of the Institute will be inspired by the panorama of municipal and office buildings, in downtown Columbus. If you miss this aero-



Downtown Columbus, Ohio

graphic view, the new sky room on the sixteenth floor of the Deshler Hotel is glassed in on three sides and affords a vista over the city and beyond. Columbus, a thriving, fast-growing city, is one of the most attractive municipalities in the great Ohio River Valley. Both the Deshler and Neil House are located in the heart of the city directly across from the State Capitol and its beautiful grounds.

PREREGISTRATION SERVICE AVAILABLE APRIL 1 TO May 28

This year, PREREGISTRATION service for the IFT National Convention in Columbus will be available from April 1 to May 28. This is to help everybody save time. To avoid the rush of registrants on the opening day, June 12, members are urged to take full advantage of PREREGISTRATION. Members who attended the Los Angeles meeting last summer will recall how quickly and easily the PREREGISTERED members were processed. Preregistrants save the time of standing in line at Convention time and have more time for a good time. Therefore, you are invited and urged to preregister, beginning April 1 and continuing through to May 28, 1955.

Procedure. The first of April, a self-explanatory PREREGISTRATION form was mailed to each member along with other descriptive information about the forthcoming Convention. Each member is urged to utilize this PREREGISTRATION form by filling in all pertinent personal data, including the names of all members of his family who will attend the Con-

(Continued on page 8)

TIME-TESTED FLAVORS for PICKLE PACKERS.....

You can now bring the fine art of pickle flavoring right into your own processing plant without resort to costly trial-and-error experimentation. How? By following a few simple suggestions and using the time-proven products of our laboratories—spicing specialties like those briefly described herewith. Into these fine materials have gone countless man-hours of painstaking scientific research, the results of which will enable you to produce a line of goods you'll be proud to label as your own. Write for test samples and working details concerning any of these products; also for FREE Flavor Data Sheets giving helpful information and suggestions for using our many dependable Pickle Spicing Compounds.

OIL DILL WEED—This outstanding specialty of our house has been used extensively by discriminating pickle packers for many years. It develops a well balanced, super-fine dill flavor.

OIL DILL PICKLE SPICE No. 1 and No. 2—These are often used in conjunction with Oil Dill Weed to produce supplementary spicing effects for both processed and pasteurized pickles.

OIL GARLIC—Here is a true garlic flavor, highly concentrated for use in Kosher type processed and pasteurized pickles.

OIL SOLUBLE GARLIC FLAVOR No. 20206—This is a convenient-to-use-and-handle dilution of natural Oil Garlic.

OIL DILL PICKLE SPICE "K" No. 1—A complete, well balanced Kosher type dill pickle flavor containing carefully blended Oil Dill Weed, Garlic and other spicing oils associated with this very popular flavor.

OIL PICKLE SPICE "K" No. 2—This highly concentrated combination of Oil Garlic and other spicing compounds will produce a very fine, characteristic Kosher-like effect. It may be used as a fortifier for Oil Dill Pickle Spice "K" No. 1; also in combination with Oil Dill Weed.

OIL SWEET PICKLE SPICE Nos. 1 to 14—These are attractive combinations of carefully selected spicing oils and oleoresins. Each produces an outstanding and characteristic flavoring effect at very moderate cost. Full descriptions of these individual flavors are available upon request.

OIL RELISH SPICE—A flavorful combination of standardized essential oils and oleoresins for producing attractive spice effects in relish mixes.

OLEORESIN TURMERIC—This dependably uniform, highly concentrated specialty of our house is recommended for use in processed and pasteurized pickles.

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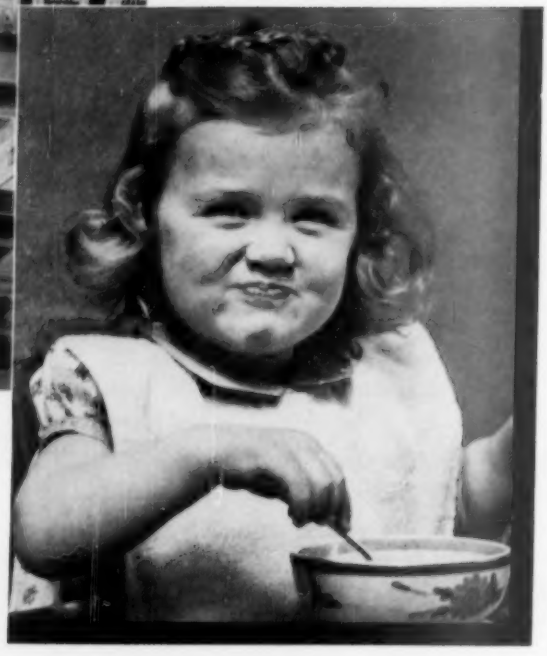
Foods move faster from counter to table



when MSG* is on the label

Payoff on processed food sales comes when shoppers reach for one brand instead of another. Make sure it's yours by using Huron MSG.

Frozen foods — chicken pies, fish, meat, poultry, and vegetables — retain their pre-freezing flavor longer when you use Huron MSG. In many cases it also helps preserve their original color.

Canned foods — soups, gravies, hash, beans and others — keep their original flavor through all three cookings (yours plus the housewife's) with Huron MSG (made *only* from wheat protein).

Small fry make a big difference in selling food.

In the shoppers' home, your product has nothing more or less than its own flavor to stand or fall on. If it passes this critical taste test, it rates a permanent place on the family shopping list.

That's why so many processors "insure" taste appeal with Huron MSG — America's first MSG and still the quality standard. You can be next!

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Rohm & Haas industrial enzymes are *natural* products which catalyze specific reactions and prevent undesirable side-reactions. They are valuable tools for the food technologist. With them he can tenderize meats, improve the texture and grain of bread, and use higher concentrations of skim milk in ice cream without danger of "sandiness".

In wine making, cereal processing, and many other food preparation operations, Rohm & Haas natural enzymes add to process efficiency and, at the same time, enhance the appeal of the final product.

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...and Tailor-Made Packaging

Nature protects many fine foods with hard shells or thick leathery coverings. But the luscious, juicy tomato is thin of skin—totally unprepared for traveling.

With this handicap, plus a fleeting harvest season, the tomato would seem unlikely to attain wide use. Yet the magic of tailor-made packaging has made it one of the most popular of vegetables.

For fresh tomatoes, tailor-made packaging supplies transparent wrappings. These not only provide protection—but let shoppers see the tomatoes in all their glory while removing any temptation to pinch or squeeze.

For millions of tons of tomatoes which are processed annually, the versatile tin can has done wonders. Cans bring whole tomatoes, pulp, juice, purée, soup and sauce to the nation's tables, giving excitement and variety to meals all year round; also tempting meat, paste and other tomato combinations. And, of course, Continental scientists and technical men work with tomato packers across the country—follow the course of this versatile vegetable all the way from the vine.

Tailor-made packaging for almost everything

With a host of materials to work with, and fifty years of experience at our command, Continental is prepared to produce tailor-made package service for nearly any product you can name. Continental Can Company, New York 17, N. Y. • Continental Can Company of Canada, Ltd., Montreal.

(This advertisement originally appeared in full-color in TIME, BUSINESS WEEK and FORTUNE.)

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Paper Containers
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Flexible Packaging
Steel Containers

ANNUAL MEETING BULLETIN BOARD

(Continued from page 2)

vention. Indicate the number of tickets desired for each event. Calculate the total cost of registration and the desired events. Send remittance for the total cost by check only. Make all checks payable to the "OHIO VALLEY SECTION, IFT." In order to qualify for PREREGISTRATION, payment in full for both registration and tickets MUST BE RECEIVED BEFORE MAY 28, 1955. Mail both your PREREGISTRATION and check to the OHIO VALLEY SECTION, IFT in care of the HORTICULTURE DEPARTMENT, Ohio State University, Columbus 10, Ohio. As the accomplished PREREGISTRATION form with accompanying check is processed, it will be assigned a number. This assigned number will be mailed to the registrant by postcard. Bring this card to the PREREGISTRATION DESK at the Convention and exchange it for your badge and tickets.

On June 12, the customary IFT Registration Line will be opened in the Deshler-Hilton Hotel, the Headquarters of the Columbus Convention. At that time, additional tickets may be procured for all events.

LET US ALL SAVE TIME—AT CONVENTION TIME—USE PREREGISTRATION TIME—BEFORE MAY 28 TIME.

Breakfasts, Luncheons, the Banquet

Beginning Monday morning, June 13th, the **Section Officers' Breakfast** will be held for the officers of all the sections which make up the Institute.

At Monday noon, the **Babcock-Hart Award Luncheon** is scheduled, one of the highlights of the convention. Awards will be presented by the Nutrition Foundation, Inc. in honor of Stephen M. Babcock and Edwin Bret Hart to a person distinguished by his contributions to food technology resulting in improved public health through some aspect of nutrition or nutritious food. Also, the **Food Engineering** Award will be presented to a company for an outstanding technological achievement in food processing.

Everyone is looking forward to the colorful midwestern **Ox Roast and Barbecue** which will be held Monday evening at the Ohio Stadium of the Ohio State University Campus. This promises to be an event you will remember and will be followed by Water Follies and championship diving at the Natatorium adjacent to the Stadium.

Tuesday morning, the **MIT Alumni Breakfast** is scheduled. Following this at noon will be **The Ohio State University Alumni Luncheon** and concurrently, the **University of Massachusetts Alumni Luncheon.** Alumni (and alumnae) of these universities will want to attend to meet old friends and recent graduates.

Tuesday evening, the **Appert Award Banquet** will be held in the beautiful, new Ohio Union Building on The Ohio State University Campus. The Nicolas Appert Medal Award, sponsored by the Chicago section, is bestowed annually at this banquet by a jury of Institute members upon one who "because of his preëminence in and contribution to the field of food technology, is deemed worthy of special recognition."

Wednesday morning is the **Committee on Education Breakfast**—open to those interested in the educational aspects of food technology.

Wednesday noon, at the **Installation Luncheon,** announcement and installation of officers for the coming year, as well as the business meeting of the Institute, will be an event of interest to all members.

Arrangements have been completed for the above events. Meal costs have been kept as reasonable as possible and excellent food and service have been promised by the catering departments. Good food and pleasant surroundings are definitely in store for you in Columbus this coming June.

NOMINEES FOR PRESIDENT-ELECT, 1955, ANNOUNCED BY IFT PRESIDENT, PHILIP K. BATES

Candidates for the post of President-Elect of the Institute of Food Technologists have been determined to be: George F. Garnatz, Kroger Food Foundation, Cincinnati, Ohio, and J. Avery Dunn, Atlantic Gelatin Division, General Foods Corp., Woburn, Mass. Drs. Dunn

DR. J. AVERY DUNN DR. GEO. F. GARNATZ

and Garnatz have both taken an energetic interest in the affairs of the Institute and have both been active in the committee work of the organization—including the arduous work of putting on an annual meeting. The election of either of these good IFT'ers and true will assure the continuation of the policies that have made the IFT the central organization for integrating the food sciences and technologies. The President-Elect is selected at the 1955 annual meeting and takes office, as President of IFT, in June, 1956. Dr. L. E. Clifcorn is the present President-Elect.

Regional Section News

PITTSBURGH SECTION

The 21st official meeting of the Pittsburgh section, IFT, was held Tuesday evening, December 14, at the Park Schenley. Organizations invited to attend were the Nutrition Council of Allegheny County, Pittsburgh Branch, Society of American Bacteriologists and the Biochemical Section of the American Chemical Society.

(Continued on page 10)

THINGS TO COME...WITH

Glycerine

TASTY CREAM CANDIES . . . with longer shelf life

Candy makers have a problem when cream fillings develop disagreeable taste and odor after a few weeks on store shelves.

They've looked long and hard for a way to eliminate this spoilage which is caused by the formation of free fatty acids.

Researchers have tried to stop or slow down the reaction by adding chemical retardants. But taste and texture could not be sacrificed.

Tests have shown that in some cases addition of 1-2% *Glycerine* almost doubles shelf life, promising a more trouble-free future for the candy industry.

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This balanced group of properties keeps **Glycerine's** usefulness growing

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☐ 20-page booklet on Glycerine for product conditioning

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REGIONAL SECTION NEWS

(Continued from page 8)

Following a pleasant social hour and dinner, the meeting was called to order by the Chairman, Mr. V. W. Vaurio.

In addition to Dr. King, the speaker of the evening, members of the participating groups seated at the speaker's table were introduced: Elena Becker, Mary E. Ewart, Robert Olsen, Robert A. Moore, William Leathen, C. V. Starrett, Dr. and Mrs. H. E. Longenecker and Dr. I. Hope Alexander.

Mr. Vaurio then asked Mr. Rumberger to introduce the speaker of the evening, Dr. C. Glenn King, Scientific Director of Nutrition Foundation, Inc. Dr. King gave an extremely interesting talk entitled "Rip Van Winkle and our Food Supply." In it he discussed his activities since leaving the University of Pittsburgh, as well as nutritional investigations being carried out both at home and abroad. Following his well illustrated talk, Dr. King participated in an interesting question and answer period.

The 22nd official meeting of the Pittsburgh Section was held Tuesday evening, February 8, at the Royal York Dining Room.

Speaker for this occasion was Dr. L. E. Clifcorn, Director of Fundamental Research, Continental Can Co. Dr. Clifcorn chose as his topic "Where Do We Stand In Regards to the Radiation of Foods." This proved to be one of the most informative and interesting talks of the present season.

NEW YORK SECTION

Chemicals in Packaging Materials Studied as Possible Hazard. Because many of the chemical components used in packaging materials are relatively new to such uses, the possibility of contamination of foods and injury to health is being studied. The nature of this problem and its technical complexities were discussed by Dr. Bernard L. Oser at the February 16 meeting of the New York Section of the Institute of Food Technologists. Dr. Oser is director of Food Research Laboratories, Inc., Long Island City, N. Y.

So far as is known no incidents have occurred to suggest a need for concern over the hazardous nature of any of the newer chemicals as used in packaging materials. To cite an actual case where a potentially injurious chemical contaminant was introduced into a food via the package, Government officials have had to dig up the old practice of shipping tea in lead-foil containers.

So the problem is not one of real or imminent danger, but rather of conformity to those provisions of the Federal law aimed at keeping foods free from poisonous or deleterious substances.

No seizures based on adulteration with chemical components of packaging materials have ever been made. However, the Food and Drug Administration has concerned itself in a very material way with this problem, owing largely to the voluntary cooperation of the chemical, packaging, and food industries. Scores of compounds have been presented for evaluation on an informal basis.

More than 175 chemical ingredients of plastic food-packing materials have been listed, and roughly half of these are regarded as unsafe or unacceptable by reason of insufficient or no toxicological data.

To the uninitiated the evaluation of the safety of chemicals in packaging material may appear to be a formidable program of study. Yet it confronts every food, chemical, or packaging manufacturer responsible for the introduction of new chemicals into foods.

PHILADELPHIA SECTION

The regular monthly meeting of the Philadelphia Section was held February 1 at Drexel Institute. The customary after-dinner film featured "The Story of Vanilla," a fascinating study of the growing, harvesting, processing and extraction of vanilla, which was produced by McCormick and Co.

Dr. John H. Nair, Assistant Director of Research for Thomas J. Lipton Co., addressed the section on "Guides to Consumer Preference in Foods." The usefulness and limitations of trained panels in comparison with consumer preference panels in the evaluation of food products were considered. Various methods of conducting consumer panels were described as, for example, the personal interview and the instruction-by-mail method. The advantages and drawbacks of these methods were discussed. Dr. Nair also gave some of the results of a study in which different types of bias in the presentation of samples were identified and evaluated. The meeting closed with a question and discussion period.

Dr. James B. Allison, Professor of Physiology and Biochemistry at Rutgers University, will be the March speaker.

GREAT LAKES SECTION

Winter Meeting

The Great Lakes Section of the Institute of Food Technologists met at the Park Shelton Hotel in Detroit, January 21, 1955. Before the meeting, many of the members enjoyed a fine talk by Mr. Howard Nassze, describing the manufacture of beer and a trip through the Goebel Brewing Company plant in Detroit. After the trip "Goebel" put on a very fine luncheon which everyone enjoyed.

The meeting was called to order by Chairman Thompson at 2:00 p. m.

The first speaker was Dr. W. A. Quammen of the Procter and Gamble Company who was very interesting and informative. His subject was Technical Aspects of Commercial Frying. After mentioning the newer fats that do not have objectionable odors, he gave some figures on the amount of foods now being fried in deep fat. He was insistent that the proper fat for the job would do a better job and went on to tell why. Mr. Quammen had charts to augment his talk and the section members were well pleased with his address.

The second speaker was Dr. R. N. Costilow of the Michigan State College Bacteriology Department and his subject was "Sorbic Acid as a Preservative for Sweet Cucumber Pickles." He gave a brief review of the development of sorbic acid as a preservative and the

(Continued on page 12)

Presenting . . .

Dri-Seal

The Latest Advancement in FLAVOR RETENTION

Shelf Life of your finished products will be materially lengthened through the use of N. B. W. DRI-SEAL, the dry food flavor which remains fresh indefinitely.

DRI-SEAL is a process whereby millions of atomized flavor globules are hermetically sealed within a shell of edible gum.

No evaporation, oxidation, deterioration through contact with air, or cross blending with other product ingredients can occur as long as the product remains reasonably moisture free.

Since the protective coating of DRI-SEAL is instantly soluble in water, the flavor is released by the consumer in its original strength at the time the product is used.

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REGIONAL SECTION NEWS

(Continued from page 10)

properties of the compound compared to those which are desired as a preservative agent. The results of studies made to date indicate that sorbic acid may be a much more efficient and desirable preservative than sodium benzoate. Data was given showing that 0.1% sorbic acid inhibited pickle spoilage yeasts very effectively in acid media. Experimental packs of sweet cucumber pickles containing 0.5% acetic acid and above, which were inoculated with the acid and sugar tolerant yeasts and with lactobacillus culture, were preserved by 0.1% sorbic acid irrespective of the sugar concentration.

The third speaker was Dr. C. L. Bedford of the Michigan State College Horticulture Department whose subject was "Research in Red Cherry Processing." He discussed the various factors that influenced the quality of the processed cherries and indicated that a better quality could be obtained by better handling of the raw product and by canning in light syrup instead of water.

The final speaker for the afternoon was Mr. B. P. Forbes of the Forbes Chocolate Company whose subject was "Food of the Gods." His pictures and historical talk brought us from the days of Montezuma to the present time with chocolate. His description of the trees, the pods, the seeds and the manufacture of cocoa and chocolate, was very interesting and he did not forget to mention that these products have real food value for young and old alike. He ended his talk with a plea that Food Technologists carry on the fight to prevent false or misleading advertising in order to get sales but that we put world and nation ahead of economics.

At 6:30 p.m. dinner was served in the Shelton Room —Boy was it a dinner!

After dinner Dr. S. H. Fox, Vice President, Pharmaceutical Research and Control, Gelatin Products Division, R. P. Scherer Corporation, gave a very provocative talk on "A Predicament in Science." This is one speech I can't brief for you and if you are one of the ones who missed it, I'm sorry for you. He was good.

Every one of the speakers was asked many questions. We had to sort of shut off the questions to get on with the show. They all had pictures, slides or charts to go with their talks and I believe everyone had an enjoyable time while meeting old friends and learning some things at the same time.

Our meetings are continually getting better in every way and if you have missed any in the past, forget about them, but resolve to miss no more. Why don't you get somebody who works with you or a friend and make a pact that you'll get to the next meeting or bust!

The meeting was adjourned at 8:45 p.m.

MARYLAND SECTION

W. J. Kindley of C. A. Swanson & Sons, Inc. told the Section all about "Poultry—Past, Present and Future" at the February 11th meeting held in Baltimore.

At the start Mr. Kindley assured the group that, concerning which came first, the egg or the chicken, it was declared by Genesis to be the chicken. He described the "New York Dressed Bird" as one defeathered and blood-let, but entrails left inside. It took six to seven days from dressing to table and, due to bad taste and slime formation caused by bacteria and enzymes, it was unpalatable.

In 1945 frozen dressed poultry took hold so that today only 40% is "New York Dressed"; 80% of this is cut up and the remainder is sold as the whole bird.

In the present day sanitary operation at Swanson's the birds are received at the loading dock and in thirty minutes are on the killing line, where their blood is let. The windpipe cannot be severed here, lest the bird strangle and fail to bleed white. After bleeding the bird is scalded at 139° F., before the feathers and outside skin are removed. Then follows evisceration and cleaning, and next U. S. Department of Agriculture inspection. Poultry parts must be cooled to 40° F. by ice slush before packing as per Government regulations. Then they may be frozen or sold iced.

Swanson has packed 100,000,000 Chicken Pies in two years, quite a figure. These are composed of mashed potatoes, mixed vegetables and white and dark meat of chicken. In Modesto, California, Swanson packs 150,000 Turkey Dinners per day (turkey, sweet potatoes, corn bread dressing, gravy). In addition to these, they also market Beef Dinners (pot roast, small brown potato, corn O'Brien and peas), Apple Pies, TV Dinners.

Food Technologists have improved the feeding and care of poultry to the extent that where it took fourteen weeks before the war for a chick to reach three pounds and the blood-letting line, it now takes only ten. It is predicted that in the future it will take only eight.

WESTERN NEW YORK SECTION

"The Scientist's Role in Business Management" was the subject discussed at the February 21st meeting of the Niagara Frontier Division, Western New York Section, IFT. Dr. R. W. Johnson of the School of Business Administration at the University of Buffalo was the speaker. He heads the School's special course, "Management Training for Scientific Personnel." The meeting was held in Erie County Institute of Applied Arts & Sciences in Buffalo, N. Y.

NORTHERN CALIFORNIA SECTION

The Section held its February meeting at Spenger's Fish Grotto in Berkeley. Thomas A. Bruce, Richard E. Heyl and Harry M. Pancoast discussed the subject: "Corn Derivatives." Tom is with Corn Products, Dick with A. E. Staley Co., and Harry with American Maize.

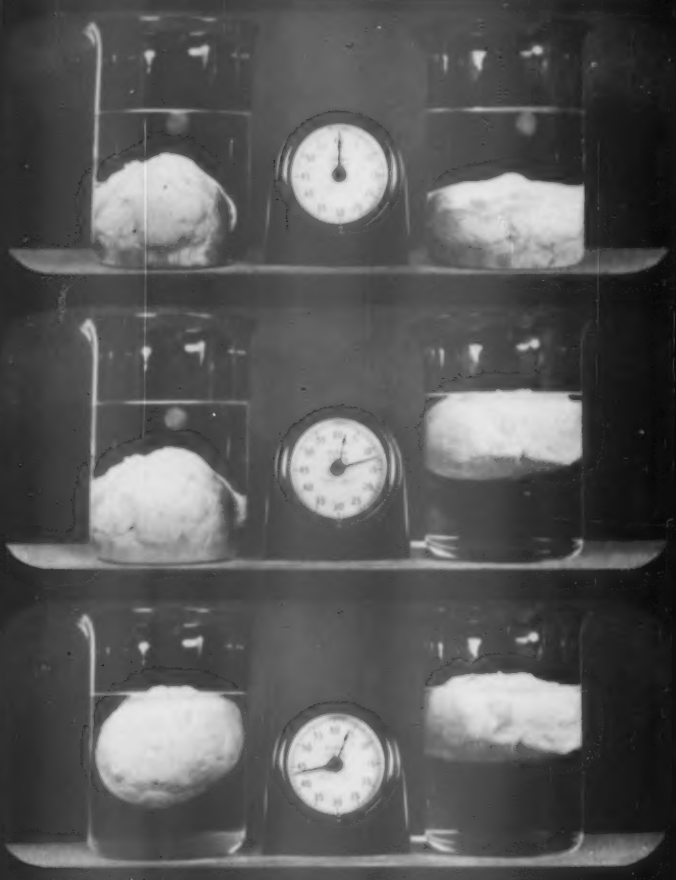
CHICAGO SECTION

The facilities of the Museum of Science and Industry were reserved for the group on Monday, February 14, 1955. Dinner and subsequent viewing of "Food for Life" exhibit were private, with the interest exemplified by one of the largest turnouts ever had—131 members and guests.

Dr. H. E. Robinson, Director of Laboratories, Swift & Company gave a fine talk on "Food for Life." Pointing out that research is usually 20 years ahead of having the findings put to practical use by the public, he showed how important this was in nutritional work since the information affects our very life and well being.

(Continued on page 14)

Proof PY-RAN* Leavens in the Oven!



Freshly mixed doughballs made with self-rising flour rest in liquid. Dough at left leavened with PY-RAN; another calcium phosphate in dough at right.

2 minutes, 12 seconds: PY-RAN dough remains at bottom. The other calcium phosphate has evolved so much CO_2 that doughball floats to top.

3 minutes, 44 seconds: PY-RAN dough finally begins rise, proof of slow controlled gas release during critical pre-oven period.

PY-RAN (anhydrous monocalcium phosphate) not only holds its leavening action for the oven, it gives longer shelf life to prepared mixes and self-rising flour. A special moisture-absorbent coating protects PY-RAN from reaction during storage. PY-RAN performs well in combination with other leavening acids, gives superb texture, volume, crust and crumb color, reduces tunneling.

You will also like SAPP-40 for machine doughnut mixes, SAPP-28, a slow-action baking acid, and HT* Phosphate (MCP monohydrate). Ask the local Monsanto representative for the new book "Monsanto Phosphate Leavening Agents," or write: Monsanto Chemical Company, Inorganic Chemicals Division, 710 N. Twelfth Blvd., St. Louis 1, Mo.

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REGIONAL SECTION NEWS

(Continued from page 12)

Problems of aging are the problems of today due to the greater number of old people and the longer span facing youth. Weight reduction was noted as one of the most important factors in this respect. Even at 12 years of age proper nutrition habits are important as it has been found that the nutritional pattern is set in early life.

Present sanitation control in food preparation, surgery and medicines protect youth from disease damage so that they get a much better start on a longer life span.

The talk received the enthusiastic approval of all present with special thanks expressed by the four international guests (one from Finland, two from Brazil and one from the Netherlands) who saw nutrition research as necessary to the entire world population.

It was followed by a viewing of the "Food for Life" exhibit at the museum. This exhibit, over two years in building, covers nutrition education for the average person, even reaching to the level of school children. It covers foods for babies up through senior citizens, touching on soil, plants, livestock, food processing, cooking and serving as well as correct eating.

SOUTHERN CALIFORNIA SECTION

The Section met in February at the usual place on the usual third Wednesday and had the usual good time. The management of the Rodger Young Auditorium seemed to realize that food for Food Technologists should be technically perfect, and it was.

After the dinner and door prizes were dispatched, our ex-1954 chairman, Dr. M. S. Dunn, was presented a certificate of appreciation for his loyal and far-sighted leadership last year. We all felt that he enhanced the prestige of the Institute in this area, and we all agree that he wielded a witty gavel.

The meeting was turned over to two young men from Beckman Instruments, Inc., of Fullerton, Calif., who really put on a show. Mr. Kenneth K. Kendall, Jr. started with an actual demonstration of the high sensitivity of jelly to pH, then went on to describe the effect of pH on purification, sterilization, preservation, and waste "disposition" in connection with all foods from "soup to nuts." Mr. Robert J. Manning followed with a highly instructive talk on spectrophotometry—transmission, reflectance, flame, and infra-red. He delved a bit into the theory of color identification by means of the three parameters, brightness, hue, and purity.

AUSTRALIA NORTHERN SECTION

The committee is pleased to announce that our Section will be hosts at the March Meeting which will be a conjoint one, with the Dieticians' Association of Australia. The ladies were "hostesses" at last year's conjoint meeting.

WHERE: C.S.I.R.O. Food Preservation Laboratory, Homebush.

WHEN: Tuesday March 1st, Buffet Dinner at 6:30 p.m.

SUBJECT: *American Food Habits.*

SPEAKERS: Professor J. C. Moyer, Department of Food Technology, Cornell University, New York, at present in Australia under the Fulbright scheme, and Dr. Mary Mann Moyer, his wife, who has been a research worker and is vitally interested in the field of nutritional science.

DETAILS: 1. Dinner charge: 10 per head—includes liquid refreshments. 2. Meeting Proper: 7:30 p.m., following buffet dinner 6:30 p.m.

CHAPTER OF PHI TAU SIGMA FOUNDED AT RUTGERS UNIVERSITY

The National Council of Phi Tau Sigma, the honor society for food science, today granted a charter for a Chapter at Rutgers University in New Brunswick, New Jersey.

Petitioning for the Rutgers Chapter were C. Olin Ball, Angela M. Filios, Ira D. Garard, Walter A. Maclinn and Elizabeth F. Stier. Dr. Maclinn is Chairman of the Department of Food Technology at Rutgers University.

The Rutgers University Chapter thus joins the existing Chapters of the society at the Massachusetts Institute of Technology and the University of Massachusetts in carrying out Phi Tau Sigma's purposes of encouraging the application of fundamental science to Food Technology, honoring and recognizing achievements in the field and promoting fellowship, thereby stimulating the free exchange of knowledge among food scientists.

In Memoriam

News of the death of Edwin J. Cameron, Director of the National Canners Association Research Laboratories for the past many years, was received with sadness by all who knew him. He passed away on March 21 at Georgetown University Hospital, Washington, D. C., as a result of a stroke. Dr. Cameron, long a member of the Institute of Food Technologists, was the recipient last June of the annual Babcock-Hart Award "for distinguished contributions to the betterment of food and by that fact to better human nutrition." Among these were his pioneering bacteriological surveys in canning factories, influential in the development of modern industrial sanitation, and his leadership of the wartime research campaign to determine the status of canned foods in human nutrition and to develop methods for their improvement.

Dr. Cameron was born September 17, 1895, at Cambridge, Mass. He attended the schools of Massachusetts, obtaining the degree of Bachelor of Science from Massachusetts Institute of Technology in 1920. His college work was interrupted by two years of service in the Medical Corps of the A.E.F. during World War I.

Dr. Cameron joined the N.C.A. staff in 1923; in 1936 he was appointed Assistant Director of the N.C.A. Washington Laboratory; in 1939, Director; and in 1955, over-all Director of the N.C.A. research laboratories.

Survivors are his widow, Mrs. Dorothy Pray Cameron, a son, John Cameron, three sisters—Mrs. J. C. Dart, Mrs. A. B. McKinney, and Mrs. John Crowell—and two brothers: Ellis Cameron and James Cameron.

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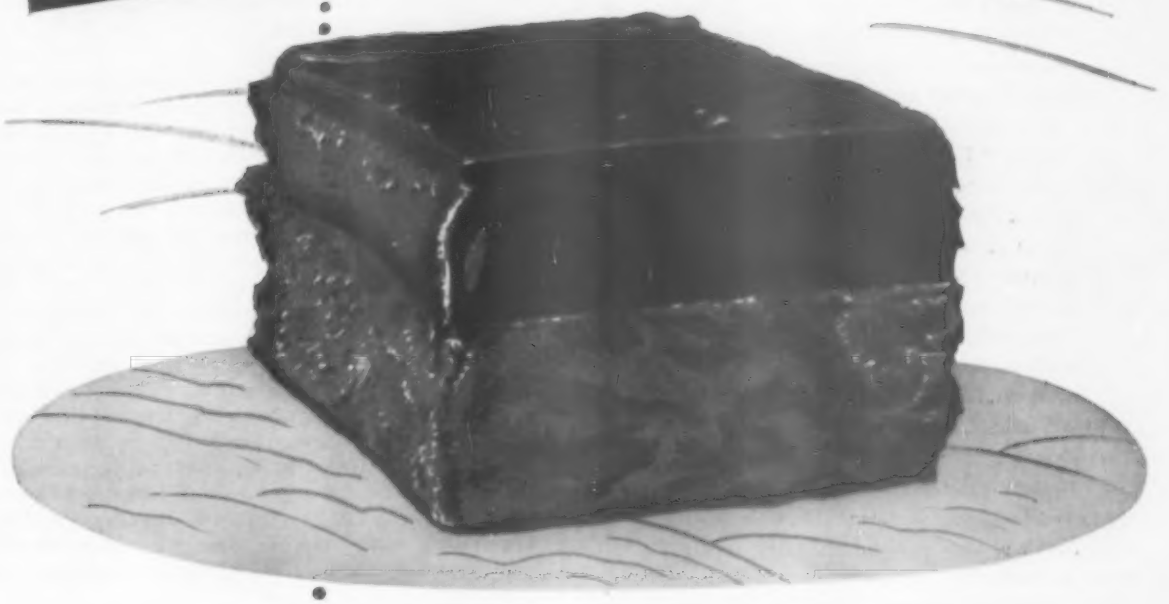

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fat modification
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Sorbitol not only stabilizes moisture content under varying humidity conditions, but also has a modifying effect on the crystallizing properties or crystal structure of mixed sugar systems. It is these two actions working in conjunction with each other which account for sorbitol's unique value as a conditioning agent for sugar-containing foods.

To your customers, sorbitol enables better retention of original flavor, tenderness, texture and appearance in such foods as shredded coconut, icings, fillings, gelatin products, whips, toppings, doughnut coatings . . . and in cream, nougat, caramel, marshmallow, fudge and centers of coated candies.

To your production men, sorbitol assists in overcoming severe production problems. The softer texture produced by sorbitol helps prevent breakage of some food preparations during manufacture and shipment. Sorbitol provides valuable help in reducing moisture loss in certain sugar-containing foods which are left in starch molds over weekends for Monday finishing.

During our many years of working with food processors, we have found a lot of technical facts on the use of sorbitol which could be useful to you. We'll be glad to explore the possibilities with you, or to send samples and literature. Just write or call Atlas today.

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Books

PRACTICAL PHYSIOLOGICAL CHEMISTRY, THIRTEENTH EDITION—By Philip B. Hawk, Bernard L. Oser and William H. Summerson. 1439 pages, XVI. The Blakiston Company, Inc., New York. Price, $25.00.

The appearance of the 13th edition of this well known text and reference will be welcomed by the biochemist, the food technologist, and others working in fields of which biochemistry is a part. The introductory statement—"It is with a mingled sense of pride and humility that the senior author presents this—the Thirteenth Edition of Practical Physiological Chemistry. To have been actively engaged in the authorship of successive editions of a textbook for fifty years is a privilege granted to few in the annals of medical publication."—attests to the important role of this book during the past half century. Its thirty-six chapters are devoted to the following subjects: physicochemical principles; carbohydrates, fats, proteins (composition, structure, and classification); nucleic acids and nucleoproteins; milk; tissues (epitheleal and connective, muscular, nervous, and bone and teeth); enzymes and their action; digestion (salivary, gastric, pancreatic, and intestinal); bile and liver function; intestinal absorption; putrefaction, detoxication, and conjugation; feces, blood, lymph, and cerebrospinal fluid; blood analysis; respiratory exchange and neutrality regulation; hormones; urine; isotopes; carbohydrate, fat, protein, energy and inorganic metabolism; vitamins and deficiency diseases; and metabolic antagonists and antibiotics.

The appendix includes several very useful sections including: table of composition of foods—raw, processed, prepared; average portions of foods, caloric values and acid- and base-forming effects; maintenance of animals for nutrition experiments including preparation and composition of diets and salt mixtures; and analysis of variance.

This edition has been extensively revised and expanded. Some of the chapters, such as those dealing with nucleic acids and nucleoprotein, milk, muscle tissue, enzymes and their action, and isotopes have been rewritten. Approximately half of the contents of this book is devoted to textual material; the other half is concerned with laboratory experiments and procedures.

The incorporation of numerous recent references (1952, 1953, 1954) is evidence of the efforts that have been made by the authors and their thirty-one well-known collaborators to bring the present edition completely up-to-date.

Although perhaps this book is better known as a text, it is to be recommended as a useful reference book of biochemistry for the food technologist. In addition to its text and factual material, this book provides a comprehensive source of many laboratory methods and procedures covering the wide fields of material embraced in its thirty-six chapters.

WILLIAM B. ESSELEN
Amherst, Massachusetts

PROCEEDINGS, SYMPOSIUM ON CURED AND FROZEN FISH TECHNOLOGY. SIK—Publication No. 100. Swedish

(Continued on page 18)

Vitamin A

and the battle of the sexes

We aren't sure what weapon it will supply in the war between men and women, but there seems to be a sex difference in vitamin A metabolism.

First off, men suffer a deficiency of vitamin A more often than women. And men have a higher plasma vitamin A value. The same with rats. But, female rats store more vitamin A in their livers than male rats do. And so on.

Some think all this may be due to sex hormones. We don't know. We're interested, though, for a number of reasons. One, for example, is that, when you run a liver storage type of bioassay, you ought to make an adjustment in your arithmetic for the difference between females and males.

A promise of reinforcements to either side is not our aim. Our business is to make vitamin A for everyone—man, woman, and child—to make it in bulk as Myvax Vitamin A Acetate or Palmitate for pharmaceutical manufacturers to use as they will; as Myvapack vitamin A in pre-measured cans for food manufacturers to add to their product, one can to a batch. We also make our vitamin A so that it tastes good, and in sufficient quantity so that we can ship it from stock. For information or a quotation, write ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York, Chicago, and Memphis • W. M. Gillies and Company, Los Angeles, Portland, and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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BOOKS

(Continued from page 16)

Institute for Food Preservation Research (SIK), Gothenberg, Sweden, 1954. Price, Sw. Cr. 25 (about $5.00).

For those interested in the microbiological, biochemical and processing aspects of fisheries technology, an excellent review of recent advances in the field is presented in the *Symposium on Cured and Frozen Fish Technology*.

The symposium was prepared from papers presented at an international conference held in Göteborg (Gothenberg) Sweden, during which, representatives from seventeen different countries participated.

The topics covered in this report are as follows: The microbiology of cured and frozen fish; Bacteriology of semi-preserved herring; Changes in Dutch salted matjes herring; The bacterial flora of fish; Microbiological problems of semi-preserved meat; Problems of fish protein denaturation; Characteristics of fish proteins; Vorschlag zur Einführung eines neuen Stickstoff-Faktors zur Berechnung des Proteingehalts von essbaren Anteil des Herings: Investigations on the unsaturated acids of fish fat; Experimental comparisons between Fladen and Iceland Herrings; Über den Fett- und Wassergehalt in Hering; Ropiness of fish brines; Freezing fish at sea; Recent developments in fish freezing technique and pending scientific problems; The scientific foundation of sanitary control of frozen and cured fish products; To what extent does fish break down through autolysis?; Fish processing by electronic irradiation. The summary of a special introductory lecture on "Recent investigations on protein breakdown" by Professor Arne Tiselius of the University of Uppsala is also included in this report.

Concerning the subjects dealt with in the report, the information provided in the various papers includes the more recent findings of research laboratories in a number of different countries.

J. T. R. Nickerson
Cambridge, Massachusetts

Radiation Sterilization of Foodstuffs. A report prepared and published by a group of students of the Harvard Graduate School of Business Administration. Cambridge, Massachusetts, 1954. Price, $10.00.

This report was organized and prepared by a group of graduate students at the Harvard Graduate School of Business Administration and is directed toward the needs of industrial management personnel rather than at those of technical men. With that in mind the volume presents the broad aspects of the potentialities of the use of ionizing radiations to preserve food. In the first three of a series of eleven chapters, the authors review the causes of food spoilage and types of radiations. They then undertake a brief review of the effect of ionizing radiations on systems involved in the food sterilization process, i.e. microorganisms, nutrients, enzymes, acceptability characteristics, etc.

Having developed the background material, an extensive discussion is made of sources of radiation and their application to the food industry pointing out cost factors and technical and public relation problems that must be considered. The authors have included summations for most chapters, a satisfactory number of general references for further reading, and a satisfactory series of charts and graphs to illustrate the points raised in the text. These have been extracted from various sources, but allow the non-technical reader to understand general principles rather than specific details. An approximate comparison of costs between soft x-rays, electrons from generators, and gamma rays from an isotope are included. Unfortunately, the comparison is somewhat misleading due to a lack of full detail regarding sterilization doses.

Although the volume accomplishes a satisfactory presentation of the principles involved without getting lost in technical details, there are a number of typographical errors that make reading difficult and at times confusing. For instance, in Chapter IV, it is assumed that eight million instead of two million rep is considered a sterilizing dose. Further, scattered throughout the text, are incorrect statements such as, in the general discussion of why foods spoil, the statement that any method of permanently deactivating enzymes *will* destroy bacteria.

Considering the background of the authors and the goal they sought to achieve, the volume offers a satisfactory semi-technical introduction to the field. A fair evaluation has been made of a highly controversial subject.

Bruce Morgan
Chicago, Illinois

Radiation Sterilization of Foods Symposium To Be Held in Chicago 10 June 1955

A symposium on the Radiation Sterilization of Food, open to all industry and institutional personnel interested in this bold experiment in food processing, is being sponsored by the Quartermaster Food and Container Institute for the Armed Forces (1819 W. Pershing Road, Chicago 9, Illinois). The host for this program will be the Research and Development Associates, Food and Container Institute, Inc. The Associates are holding their Eighth Annual Convention, in Chicago, during the period of 8 to 10 June 1955. The date of the symposium is June 10; the place is the Palmer House, site of the Associates' annual meeting.

The program of the symposium will include detailed reports on the background and organization of the program on radiation sterilization, the military implications and potential of the process, the comprehensive research and development program being sponsored by the QMFCI and now well under way, and the status of the art as of this date. In addition, a survey of the present and future outlook of radiation sources will be presented.

Applications for attendance should be made through the Commandant, QMFCI, 1819 W. Pershing Road, Chicago 9, Illinois. Although it is desired that all who have a serious interest in radiation sterilization of foods be admitted, space limitations make it necessary to hold attendance to those who have made formal application. No fee is being charged. It is contemplated that the proceedings of the symposium will be published.

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Selected Abstracts*

ANALYTICAL METHODS

Determination of moisture in chocolate.

SLOMAN, K. G., BORKER, E., AND REUSSNER, M. D. *J. Agr. Food Chem., 2,* 1237 (1954).

After extn. with boiling MeOH moisture in chocolate is detd. by Karl Fischer titration in the presence of the sample.

Recent developments in white sugar colorimetry.

GILLETT, T. R., AND HEATH, W. D. *Anal. Chem., 26,* 1780-4 (1954).

Considerable progress has been made in the standardization of methods and instruments for detn. of color of white sugar solns. A survey of methods showed the need for uniformity. A standardized method has been accepted as an interim procedure by the U. S. National Committee of the International Commission for Uniform Methods of Sugar Analysis. An improved white sugar colorimeter has also been developed and is now being tested.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Albumin from heated human plasma. III. Denaturation kinetics. Influence of acetate ions.

GIBBS, R. J. *Arch. Biochem. Biophys., 52,* 340-7 (1954).

The process of denaturation follows first-order kinetics with respect to protein concn. and also appears to be first order with respect to acetate.

Studies of animal skin proteins. XI. Separation of the protein constituents of animal skin.

STUBBINGS, R. L. *J. Am. Leather Chemists Assoc., 49,* 659-78 (1954).

A method was developed and tested quantitatively for the sepn. of animal skin into various protein fractions: long hair, coagulable proteins, non-protein N, collagen, epidermal proteins and short hair (the hair beneath the skin surface), and elastin. The method consists of the selective removal of the various fractions from skin by means of various chem. reagents. The errors inherent in the method have been noted and evaluated where possible. A simple method for the sepn. of coagulable proteins gelatin and non-protein N from solns. consists of the selective pptn. of the coagulable proteins with trichloracetic acid and then the gelatin with tannic acid leaving the non-protein N in soln. The chem. reactivity of various purified protein fractions of animal skin has been investigated including hydrolysis by acids, bases, and enzymes.

Analytical chemistry of the proteins and amino acids.

SPRINGALL, H. D. *Roy. Inst. Chem. Lectures, Monographs and Repts. No. 4,* 17 pp. (1954).

A review. Two general cases can be discussed, that involving specific tests without preliminary sepn. and that involving complete sepn.

Identification of amino sugars by paper chromatography.

STOFFYN, P. J., AND JEANLOZ, R. W. *Arch. Biochem. Biophys., 52,* 373-9 (1954).

A method is described which permits sepn., identification, and detn. of glucosamine and galactosamine by paper chromatography. Amts. as small as 2-5 γ of one of the amino sugars can be detected in the presence of more than 110 γ of the other.

Diastatic hydrolysis of starch in air-dried substances.

KIERMEIER, F., AND CODURO, E. *Biochem. Z., 325,* 280-7 (1954).

The rate of enzymic hydrolysis of starch increases as the H_2O content of the material increases from 14-42%, but remains const. with further increase in H_2O content. The enzyme is still active even at a H_2O content of only 5.5% (corresponding to a 46% relative humidity).

On the mechanism of enzyme action. LVIII. Acetyl-trypsin, a stable trypsin derivative.

RAM, J. S., TERMINIELLO, L., BIER, M., AND NORD, F. F. *Arch. Biochem. Biophys., 52,* 464-77 (1954).

Acetylated trypsin is homogeneous in the ultracentrifuge and presents a slight inhomogeneity in electrophoretic migration. Its isoelec. pt. is about pH 3.8. Owing to blocking of the ε-amino groups of lysine, acetylated trypsin is stable in alk. media and is not subject to self-digestion. Its stability in acid media, is, however, smaller than that of the unmodified enzyme. Its thermal stability is also slightly lower than that of trypsin. Ca^{++} ions stabilize both enzymes. The pH optimum of digestion for casein is shifted to more alk. pH values when the enzyme is acetylated.

Differential fractionation of hydrogen isotopes in liver and mammary gland.

GLASCOCK, R. F., AND DUNCOMBE, W. G. *Biochem. J., 58,* 440-7 (1954).

A theory is presented in which it is predicted that biol. fractionation of H isotopes during the reversible incorporation of water H into any metabolite will be observed only under conditions of net synthesis and not under conditions of turnover.

The keto acids of plants. Their identity, analysis, and metabolic roles.

TOWERS, G. H. N. *Dissertation Abstr., 14,* 1903 (1954).

The new procedure used depends on the fixation of the keto-acids in the form of their hydrozones to amino acids by hydrogenolysis using platinum oxide as catalyst. The amino acids so formed are chromatographed on paper, recognized by their position and reaction with ninhydrin and, where necessary, the amino acids are quantitatively detd. by a procedure already available.

Synthesis of sucrose by a partially purified plant tissue extract.

TURNER, J. F. *Nature, 174,* 692-3 (1954).

In the present communication the results of some expts. with a partially purified pea ext. are briefly described.

MICROBIOLOGY

Crystalline bacterial arrays and specific long-range forces.

GOLDACRE, R. J. *Nature, 174,* 732-4 (1954).

The purpose of this communication is to show that like viruses, some bacteria can be crystd. The bacterial cells form regular 3-dimensional arrays in which each cell corresponds to a mol. in a conventional crystal; with rod-shaped bacteria, the rods are parallel.

Classification and identification of yeasts. Part I.

LODDER, J., AND KREGER-VAN RIJ, N. J. W. *Lab. Practice, 3,* 483-90 (1954).

The aim of this article is to give the reader some general information on the classification of yeasts and the methods used for their identification. The taxonomy is treated more from the practical than from the theoretical viewpoint.

NUTRITION

Sodium-restricted diets.

COUNCIL ON FOODS AND NUTRITION. *J. Am. Med. Assoc., 156,* 1252-3 (1954).

Conclusion of a series of 3 articles. Discussed are complications of Na restriction and contraindications to its uses.

Nitrogen balance as related to caloric and protein intake in active young men.

CALLOWAY, D. H., AND SPECTOR, H. *Am. J. Clin. Nutrition, 2,* 405-21 (1954).

The findings, plus others cited from the literature, suggest that a versatile food unit of 500 cals. (7-8% of which are derived from protein) would be more practical and physiological in the development of a military survival ration, or a short-term civilian emergency feeding.

Treatment of obesity with a low protein calorically unrestricted diet.

DOLE, V. P., SCHWARTZ, I. L., THAYSEN, J. H., THORN, N. A., AND SILVER, L. *Am. J. Clin. Nutrition, 2,* 381-91 (1954).

(Continued on page 22)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

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WORLD'S LARGEST SUPPLIERS OF VANILLIN

SELECTED ABSTRACTS

(Continued from page 20)

Limitation of protein appears to be a useful adjunct to the treatment of obesity; but, as with any other diet, regular medical supervision is essential. It offers a means of regulating appetite during the maintenance period that follows any successful course of reduction, and suffices as a sole measure of treatment for milder degrees of overweight.

Apparent digestibility of dietary protein as function of protein level.

CRAMPTON, E. W., AND RUTHERFORD, B. E. *J. Nutrition, 54,* 445-51 (1954).

Coeffs. of apparent digestibility of protein for rats were obtained on a wide range of combinations of wheat, methocel, egg and cheese. Partial regression and multiple correlation analysis of the data revealed that the greatest portion of the variation in the protein digestibility coeff. is accounted for by the percentage of protein in the diet.

Intestinal absorption of glucose in protein-deficient and in starving rats.

HELLER, H. *Brit. J. Nutrition, 8,* 370-9 (1954).

Intestinal glucose absorption was studied by Cori's (1925) method in rats fed on three protein-deficient diets and in rats that had been fasted for 48 hr. and for 96 hr. The mean amts. of glucose that disappeared from the gastro-intestinal tract during a standard period were reduced in protein-deficient animals. Alimentary glucose-tolerance curves in the rats on protein-deficient diets did not differ substantially from those obtained in controls.

The effect of age on the protein and methionine requirements of the rat.

HARTSOOK, E. W. *Dissertation Abstr., 14,* 1487 (1954).

The decreases in the requirements of both methionine and cystine and of protein as the animal progressed from youth to maturity were exponential in type and statistically significant.

Effect of high plant protein regimens on the liver of dogs.

AUBERTIN, E., RIVIERE, J., LOISEAU, P., DEBOT, P., AND MALINEAU, R. *Am. J. Clin. Nutrition, 2,* 413-21 (1954).

In large amts., peanut residue meal produces lesions of a rapid fatty degeneration of the liver; soya meal causes a similar process, although a slower one, which leads eventually to the development of a classic annular cirrhosis; sunflower seed meal leads only to modifications of the mitochondria. These 3 foods cause the appearance of serum disturbances, easily demonstrated by liver function tests. Meals made from the oil-free residues of peanut, soya, and even sunflower seed are not to be recommended in the dietary of patients with liver disease.

Effects of a fat-free diet on growing male rats with special reference to the endocrine system.

PANOS, T. C., AND FINERTY, J. C. *J. Nutrition, 54,* 315-29 (1954).

Rats were fed, from the time of weanling and for a period of 20 wks., a synthetic diet completely devoid of fat. Eighteen animals maintained under identical conditions were fed Purina Laboratory chow to serve as controls. Constant findings in the rats fed fat-free diets were impaired growth, the body wt. attained being 66% that of controls; typical skin lesions on tail, feet and back, beginning after 8 wks. on the deficient diet; and increased O_2 consumption demonstrable as early as 2 wks.

Effects of adding penicillin and aureomycin to the diet of cats.

DICKINSON, C. D., AND SCOTT, P. P. *Brit. J. Nutrition, 8,* 380-5 (1954).

The addn. of penicillin and aureomycin to a diet contg. 50% protein, mostly of animal origin, produced increased growth in kittens, accompanied by increased food intake and increased efficiency of food conversion, greater freedom from infection and an improvement in general health.

Recent studies of intrinsic factor and the utilization of radioactive vitamin B_{12}.

SCHILLING, R. F. *Federation Proc., 13,* 769-75 (1954).

For the present, intrinsic factor may be considered to exert a unique type of biol. activity, for no other substances are known to be secreted exclusively for the enhancement of absorption of a specific vitamin from the normal diet. That there may be "intrinsic factors" for other essential nutrients is an intriguing consideration.

An unidentified chick-growth factor found in litter.

JACOBS, R. L., ELAM, J. F., FOWLER, J., AND COUCH, J. R. *J. Nutrition, 54,* 417-26 (1954).

A hitherto unrecognized chick-growth factor present in litter is reported. The factor is thermostable and probably produced by microbial fermentation.

PHYSIOLOGY AND MEDICINE

Participation of brown fat in pathogenesis of experimental poliomyelitis of monkeys.

SHWARTZMAN, G., AND ARONSON, S. M. *Proc. Soc. Exptl. Biol. Med., 86,* 767-71 (1954).

Following peripheral inoculation, poliomyelitis virus (Type 1) proliferates in the brown fat of cortisone-treated monkeys during the preparalytic and paralytic stages of the disease. On subsequent peripheral passage of infected brown fat, the virus can be detected in the brown fat in the absence of cortisone treatment. Characteristic brown fat lesions are incidental to viral proliferation.

Nutritive inadequacy of whole blood to support protein repletion.

FROST, D. V. *Proc. Soc. Exptl. Biol. Med., 86,* 742-4 (1954).

The inadequacy of whole human blood to serve as the sole dietary source of amino acids for repletion in the protein-depleted rat is demonstrated. Fortification of blood with isoleucine and methionine, the 2 indispensable amino acids in which blood is most deficient, largely corrects this nutritive inadequacy.

Observations concerning the production and excretion of cholesterol in mammals. XIII. Role of chylomicra in transport of cholesterol and lipid.

BYERS, S. O., AND FRIEDMAN, M. *Am. J. Physiol., 179,* 79-84 (1954).

Dietary absorbed cholosterol was found to travel in the intestinal lymph almost totally in particulate (chylomicron) form. A considerable portion of dietary absorbed cholesterol also travels in particulate form in the plasma of the cholesterol-fed animal. Cholesterol synthesized by the animal itself under normal, and also under hypercholatemic conditions, travels in sol. form in plasma.

Prevention of alloxan diabetes by sodium nitrite and paraminopropiophenone.

VOLLMER, E. P., CAREY, M. M., GOLDEN, R. G., AND GILMORE, J. W. *Science, 120,* 944 (1954).

Sodium nitrite and paraminopropiophenone, previously found to produce increased blood sulfhydryl, when injected subcutaneously into rats ½ hr. before an intraperitoneally injected diabetic dose of alloxan, markedly protected the animals against diabetes. The results support the theory that the level of blood sulfhydryl is the detg. factor in prevention of this type of diabetes.

TOXICOLOGY

The chronic dermal toxicity of a series of polyethylene glycols.

TUSING, T. W., ELSEA, J. R., AND SAUVEUR, A. B. *J. Am. Pharm. Assoc., Sci. Ed., 43,* 489-90 (1954).

It would appear that these polyethylene glycols would produce no harmful effects when used in applications that might involve prolonged, extensive contact with the human skin.

DETERGENTS

Rating detergent performance.

MCCABE, E. M. *Soap Chem. Specialties, 30,* 44-7, December, 1954.

A discussion of machines commonly used for evaluating detergents and technics for measuring soil removal from fabrics.

(Continued on page 26)

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SELECTED ABSTRACTS

(Continued from page 22)

ENGINEERING AND PLANT EQUIPMENT

Low temperature dehydration of foods.

Food, 23, 465-6 (1954).

Low temp. dehydration has proved successful, and denaturing of proteins has been successfully avoided, together with other undesirable consequences of ordinary dehydration. New methods of enzyme inactivation and protective coating have been discovered. Aphydatosis may be considered to be as economical as the standard method of dehydration and the final, dried product is of much finer quality than foods dried by the latter method. The technic is capable of being applied industrially for drying food in large quantities.

Research into the performance of atomizers for liquids.

Fraser, R. P. *J. Imp. Coll. Chem. Eng. Soc., 7,* 52-69 (1953).

This article confines itself to a very brief summary of some of the more important contributions to this subject which have been made by the researches carried out in the Jet Research Laboratory within the last eight years. The spray is photographed by high speed technics and the spray angle measured, and the manner of liquid disintegration studied. Part of the spray is caught in oil and a direct size analysis is made from a photographic record of the drops suspended in the oil. The uniformity of spray distribution is analyzed by spraying liquid from a stationary nozzle on to a horizontal surface, or from a moving nozzle on to a vertical surface, and the relative deposition vols. and transit losses are obtained. The flow inside and outside the nozzle is analyzed and related to the design and a theory of flow is developed. The aims of the various research projects have been closely coordinated so that the results obtained appear as direct answers to the fundamental aspects of the spraying of liquids.

Heat transfer in cross-flow heat exchangers and packed beds. Evaluation of equations for penetration of heat or solutes.

Klinkenberg, A. *Ind. Eng. Chem., 46,* 2285-9 (1954).

A mathematical survey and analysis of the solutions of the basic equations for the transfer of heat of solute in percolators.

Kinetics of batch adsorption and desorption.

Dryden, C. E., and Kay, W. B. *Ind. Eng. Chem., 46,* 2294-2300 (1954).

A method for detg. rate consts. is presented. For solid-liquid phase adsorption the rate of approach to equil. can be estd. by the methods of correlation presented.

FOOD AND FOOD TECHNOLOGY

CHEMICALS IN FOODS

New standards for lead content of food.

J. Am. Med. Assoc., 156, 1188 (1954).

The daily intake of Pb by a normal person is put at about 0.4 mg.; the amt. ingested would be much greater for a heavy drinker or Pb worker. As between 1 and 2 mg. of Pb can be ingested daily without toxic effect, and the consumption of 2 lb. (0.9 kg.) of food contg. 1 p.p.m. would contribute 0.9 mg., "it is clear the limits of contamination of foods and beverages must be kept very low if the safety limit is not to be exceeded." Recommended limits are also given for soft drinks, edible fats and oils, sugar, ice cream, canned meats, and fish, tea, and solid pectin.

Conservatism in estimating the hazards of pesticidal residues.

Lehman, A. J. *Assoc. Food & Drug Officials U. S. Quart. Bull., 18,* 87-90 (1954).

It is not a "fact" that the small amts. of insecticidal residues man now ingests are harmless; there are no unimpeachable data that can prove this even beyond a reasonable doubt. Conservatism, to serve as a brake for indiscriminate use of insecticides, should govern all actions at the present time. In taking a conservative attitude there is no necessity to restrict the use of insecticides below limits where they would serve a useful purpose. But the attitude should be strictly maintained that a relaxation of controls is not justified on the basis of present scientific knowledge.

FATS AND OILS

Occurrence of fatty acids with uneven-numbered carbon atoms in natural fats.

Shorland, F. B. *Nature, 174,* 603 (1954).

A note claiming isolation of pure *n*-pentadecanoic acid from hydrogenated mutton tallow and hydrogenated shark liver oil, and from butterfat without recourse to hydrogenation.

GELATIN AND GUMS

Demonstration of ornithine in gelatin by ion exchange chromatography.

Hamilton, P. B., and Anderson, R. A. *J. Biol. Chem., 211,* 95-102 (1954).

Ornithine was found among the amino acid constituents of some of the gelatins investigated. It was concluded that ornithine was formed by alk. degradation of arginine during the immersion in $Ca(OH)_2$ suspension for 5 or more weeks, part of the manufg. process of gelatin.

Manufacture of alginates.

Mfg. Chemist, 25, 501 (1954).

References on the manufg., extg. and uses of alginates. Twenty-two references including patents, also several books, are listed as sources of information on seaweed. Patents are essentially Japanese.

PECTINS

On the determination of acetyl groups in pectic substances.

Kertesz, Z. I., and Lavin, M. I. *Food Research, 19,* 627-32 (1954).

Silicic acid column chromatography, applied to a study of the detn. of the acetyl groups of pectins, was found useful in establishing the saponification treatment which will give complete removal of the acetyl groups. The absence of formic acid can be taken as an indication that the conditions of saponification were not unduly severe. A 3-hour treatment in 0.2 *N* NaOH at 20-25° C. gave satisfactory results with the pectin prepn. tested during the course of these investigations. A simple, quick method is described for the detn. of acetic acid in pectin digests by extn. with an immiscible solvent.

SIRUPS AND SUGARS

Contribution to the carbohydrate chemistry of maple sap and sirup.

Porter, W. L., Hoban, N., and Willits, C. O. Food Research, *19,* 597-602 (1954).

Maple sap, if collected under sterile conditions, contains less than 0.0001% by wt. of monosaccharides. It has been demonstrated to contain at least 5 oligosaccharides in addn. to sucrose. One fraction isolated by paper chromatography and apparently homogeneous by chromatographic standards was shown to be a mixt. of 2 trisaccharides which lends credence to the possibility that other fractions may be mixts. One of the 2 trisaccharides of the mixed fraction has been established to be raffinose or a closely related compd. and the second to be a glucosyl sucrose.

VEGETABLES

Observations of the lipid constituents of white potatoes.

Highlands, M. E., Licciardello, J. J., and Herb, S. F. *Am. Potato J., 31,* 353-7 (1954).

It is proposed that the "off" flavor developed in dehydrated potatoes on prolonged storage results in part from the oxidative rancidity of lipid material.

PACKAGING

The beater addition of phenolic-rubber combination. Part I.

Krajewski, R., and Stannett, V. *Tappi, 37,* 455-9 (1954).

Interesting mechanical properties are imparted to paper by addn. of combinations of phenolic resin (Durez) and synthetic rubber (Hycar). Both dry and wet strength are greatest when

(Continued on page 28)

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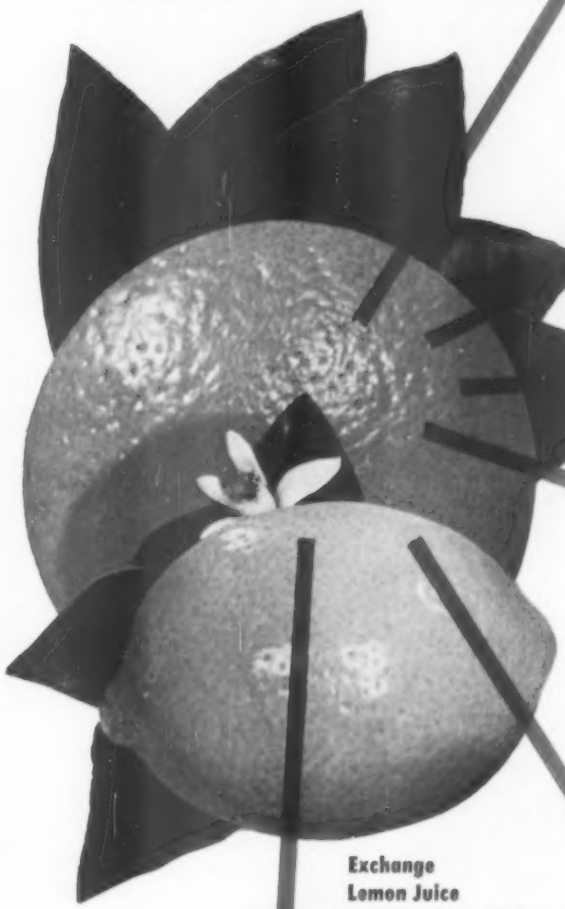

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SELECTED ABSTRACTS

(Continued from page 26)

the combination of additives is used, i.e., the blend gives better properties than either polymer used alone.

PHYSICAL RESEARCH

Precise measurements of particle surface area with microscope. PIDGEON, F. D., AND DODD, C. G. *Anal. Chem., 26,* 1823-8 (1954).

The projected-area method has been modified for direct microscopic measurement of the specific surface areas of non-porous particulate matter, such as convex, irregularly shaped, cryst. particles. The need for measuring or assuming "shape factors" and for detg. suitable statistical methods for averaging size-distribution data, as in measurement of particle "diameters," is eliminated. The method is accurate and direct and requires only 2-6 hrs. per sample compared with several days by earlier procedures.

MISCELLANEOUS INFORMATION

Reaction between phthalein dyes and heated foodstuffs. FROLICK, A. *Nature, 174,* 879 (1954).

Cresol red is discussed as a reagent for distinguishing between under-heated, properly heated and over-heated foods.

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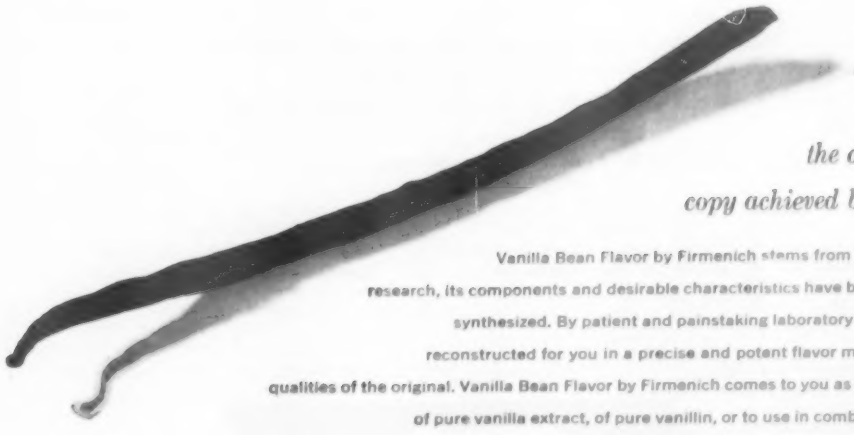

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Algebraic and Graphic Solutions of Mixing Problems Involving Adjustment of Total Solids and Ratio of Solids to Citric Acid in Fruit Juices[a]

WILLIAM KROEHLE[b]

(Manuscript received July 13, 1954)

A "negative sugar" concept, tables of sugar requirements, and facile nomographs greatly simplify the calculation of proportions of juices required to obtain a specified Brix,[c] ratio,[d] or Brix and ratio simultaneously. These methods, plus a quite general graphic method for batching or correcting batches with any three possible materials, comprise a complete system of batch calculation which has proven its ease, speed, and accuracy in actual practice.

Methods of calculating blending problems involving Brix have been treated in a few articles and texts *(4, 7, 8, 9)*. Tables of the amount of cutback juice required to blend concentrate to a few Brix values *(5, 6)*, and of the amount of 45° Brix concentrate or sugar *(7)*, and a chart for the sugar *(2)* required to raise the Brix of single-strength juice, have been published. Material on the calculation of Ratio problems *(1, 9)* is scarce because they are more complex. The mixing of three materials to a specified Brix and Ratio simultaneously, and the correction of off-batches present unique problems to which a graphic method *(3)* and a comprehensive nomograph *(1)* may be applied, but these methods do not lend themselves well to routine work. A need was felt for a rapid and complete system of calculating and adjusting batches of orange concentrate, especially for plants with no automatic proportioning equipment.

THE "NEGATIVE SUGAR" CONCEPT

The amount of sugar required to raise the Brix or Ratio to any desired value can be easily calculated by means of well-known formulas and the amount so computed can be added; but the amount of sugar which would have to be removed (if it were possible) to lower the Brix or Ratio has mathematical utility in spite of its physical limitations. From the respective sugar requirements we can calculate the proportions of 2 juices required to obtain a mixture of a specified Brix or Ratio without involving sugar as such. It is simply a matter of balancing the sugar deficiency of the low-Brix or low-Ratio juice against the sugar excess of the high-Brix or high-Ratio juice.

In developing this concept quantitatively, the following symbols are used:

G = gallons of juice
w = weight of juice per gallon, pounds
W = total weight of juice, pounds
s = weight of solids per gallon, pounds
B = degrees Brix = % dissolved solids by weight
A = % anhydrous Citric acid by weight
$R = \frac{B}{A}$ = Brix to Acid ratio, or simply "Ratio"
S = total weight of sugar, pounds
P = pounds of sugar required to adjust the Ratio of 100 gallons of juice to a predetermined value
Q = pounds of sugar required to adjust the Brix of 100 gallons of juice to a predetermined value

I. Proportions of ingredients required to produce any desired Brix. If we have one juice with a Brix higher than that desired, and a second juice whose Brix is lower, they may be mixed to produce the desired Brix. The proper proportions are given by:

(Gallons juice$_2$) × (sugar deficiency per gallon of juice$_2$) = (Gallons juice$_1$) × (sugar excess per gallon of juice$_1$).

Solving for Gallons juice$_2$ and using the symbols assigned,

$$G_2 = G_1 \left(-\frac{Q_1}{Q_2} \right).$$

The negative sign appears because Q_1 is itself negative,[e] since it represents the amount of sugar which would have to be removed (if possible) to lower the Brix to the desired value. Instead of removing it, it is in effect added to the other juice to make up for the latter's deficiency. Thus the use of Q values reduces the calculation of the volume of added juice required to a simple proportion.

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[c] Defined as % dissolved solids by weight. Strictly "degrees Brix" (1° = 1%), but herein called simply "Brix."

[d] Defined as

$$\frac{\text{degrees Brix}}{\text{\% Acid by weight}},$$

and herein called simply "Ratio."

[e] Analytically, the weight of sugar required to adjust the Brix of 100 gallons of juice to any desired value is well-known in the form

$$Q = 100 w_j \frac{B_d - B_j}{100 - B_d},$$

where the subscripts j = juice and d = desired. Also, the formula for the volume of added juice required with a given

volume of starting juice to obtain a specified Brix is well-known in the form

$$G_1 = G_2 \frac{w_2(B_2 - B_d)}{w_1(B_d - B_1)},$$

where the subscript 1 refers to the starting juice and 2 to the added juice. Dividing the numerator of the above fraction by $(100 - B_d)$ gives

$$w_2 \frac{B_2 - B_d}{100 - B_d}, \text{ which is } -\frac{Q_2}{100}.$$

Dividing the denominator by

$$(100 - B_d) \text{ gives } w_1 \frac{B_d - B_1}{100 - B_d},$$

which is $\frac{Q_1}{100}$. Hence $G_2 = G_1 \left(-\frac{Q_1}{Q_2}\right)$.

The values of Q have been calculated for juice from 11 to 15° Brix, 57 to 59° Brix, and 40 to 50° Brix, presented in Tables 1, 2, and 3, respectively. The desired Brix in each case covers the range 40 to 48° Brix in intervals of 0.5°. This range is considerably wider than that for finished concentrate so as to facilitate the correction of off-batches. Consider the problem:

TABLE 1

Values of Q_1 = pounds sugar required to raise Brix of 100 gallons cut-back juice to desired value

Brix of juice	Desired Brix																
	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	48.0
11.0	420	431	442	453	464	476	488	500	512	524	537	550	563	577	590	604	618
11.2	417	428	439	450	462	473	485	497	509	522	534	547	560	574	587	601	615
11.4	415	426	437	448	459	471	482	494	507	519	532	545	558	571	585	598	613
11.6	412	423	434	445	457	468	480	492	504	516	529	542	555	568	582	596	610
11.8	410	420	431	443	454	465	477	489	501	514	526	539	552	565	579	593	607
12.0	407	418	429	440	451	463	474	486	499	511	523	536	549	563	576	590	604
12.2	405	415	426	437	449	460	472	484	496	508	521	533	546	560	573	587	601
12.4	402	413	424	435	446	457	469	481	493	505	518	531	544	557	570	584	598
12.6	399	410	421	432	443	455	466	478	490	503	515	528	541	554	568	581	595
12.8	397	407	418	429	441	452	464	476	488	500	512	525	538	551	565	578	592
13.0	394	405	416	427	438	449	461	473	485	497	510	522	535	548	562	576	590
13.2	392	402	413	424	435	447	458	470	482	494	507	520	532	546	559	573	587
13.4	389	400	410	421	433	444	456	467	479	492	504	517	530	543	556	570	584
13.6	386	397	408	419	430	441	453	465	477	489	501	514	527	540	553	567	581
13.8	384	394	405	416	427	437	450	462	474	486	499	511	524	537	550	564	578
14.0	381	392	402	413	425	436	447	459	471	483	496	508	521	534	548	561	575
14.2	378	389	400	411	422	433	445	456	468	481	493	505	518	531	545	558	572
14.4	376	386	397	408	419	430	442	454	466	478	490	503	515	529	542	555	569
14.6	373	384	394	405	416	428	439	451	463	475	487	500	513	526	539	552	566
14.8	371	381	392	403	414	425	437	448	460	472	484	497	510	523	536	550	563
15.0	368	378	389	400	411	422	434	445	457	469	482	494	507	520	533	547	560

TABLE 2

Values of Q_c = pounds sugar required to adjust the Brix of 100 gallons evaporator concentrate to desired value*

Brix concentrate	Desired Brix																
	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	48.0
57.0	300	293	287	280	274	267	260	253	246	238	231	223	216	208	200	191	183
57.1	302	295	289	282	276	269	262	255	248	240	233	225	218	210	202	194	185
57.2	304	297	291	284	278	271	264	257	250	242	235	227	220	212	204	196	187
57.3	306	299	293	286	280	273	266	259	252	244	237	229	222	214	206	198	190
57.4	307	301	295	288	281	275	268	261	254	246	239	231	224	216	208	200	192
57.5	309	303	297	290	283	277	270	263	256	248	241	234	226	218	210	202	194
57.6	311	305	299	292	285	279	272	265	258	250	243	236	228	220	212	204	196
57.7	313	307	300	294	287	281	274	267	260	252	245	238	230	222	214	206	198
57.8	315	309	302	296	289	283	276	269	262	255	247	240	232	224	216	208	200
57.9	317	311	304	298	291	285	278	271	264	257	249	242	234	226	219	210	202
58.0	319	313	306	300	293	287	280	273	266	259	251	244	236	228	221	213	204
58.1	321	315	308	302	295	289	282	275	268	261	253	246	238	231	223	215	207
58.2	323	317	310	304	297	291	284	277	270	263	255	248	240	233	225	217	209
58.3	325	318	312	306	299	292	286	279	272	265	257	250	242	235	227	219	211
58.4	327	320	314	308	301	294	288	281	274	267	259	252	245	237	229	221	213
58.5	328	322	316	310	303	296	290	283	276	269	262	254	247	239	231	223	215
58.6	330	324	318	312	305	298	292	285	278	271	264	256	249	241	233	225	217
58.7	332	326	320	314	307	300	294	287	280	273	266	258	251	243	235	227	219
58.8	334	328	322	316	309	302	296	289	282	275	268	260	253	245	238	230	222
58.9	336	330	324	317	311	304	298	291	284	277	270	262	255	247	240	232	224
59.0	338	332	326	319	313	306	300	293	286	279	272	265	257	249	242	234	226

* All values of Q_c in this table are negative.

TABLE 3

Values of Q_b = pounds sugar required to adjust the Brix of 100 gallons batch to desired value

Brix of batch	Desired Brix																
	40.0	40.5	41.0	41.5	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	48.0
40.0	0	8	17	25	34	43	52	61	70	80	89	99	109	119	130	140	151
40.5	—8	0	8	17	25	34	43	52	61	71	80	90	100	110	121	131	142
41.0	—16	—8	0	8	17	26	35	44	53	62	72	81	91	101	112	122	133
41.5	—25	—17	—8	0	9	17	26	35	44	54	63	73	82	92	102	113	124
42.0	—33	—25	—17	—8	0	9	17	26	35	45	54	64	73	83	93	104	114
42.5	—41	—33	—25	—17	—9	0	9	18	27	36	45	55	64	74	84	95	105
43.0	—50	—42	—34	—25	—17	—9	0	9	18	27	36	46	55	65	75	85	96
43.5	—58	—50	—42	—34	—26	—17	—9	0	9	18	27	37	46	56	66	76	86
44.0	—67	—59	—51	—43	—34	—26	—18	—9	0	9	18	27	37	47	57	67	77
44.5	—75	—67	—59	—51	—43	—35	—26	—18	—9	0	9	18	28	38	47	57	67
45.0	—84	—76	—68	—60	—52	—44	—35	—27	—18	—9	0	9	19	28	38	48	58
45.5	—92	—84	—77	—69	—61	—52	—44	—36	—27	—18	—9	0	9	19	28	38	48
46.0	—101	—93	—85	—77	—69	—61	—53	—45	—36	—27	—18	—9	0	9	19	29	39
46.5	—109	—102	—94	—86	—78	—70	—62	—54	—45	—36	—27	—18	—9	0	10	19	29
47.0	—118	—111	—103	—95	—87	—79	—71	—63	—54	—46	—37	—28	—19	—9	0	10	20
47.5	—127	—119	—112	—104	—96	—88	—80	—72	—63	—55	—46	—37	—28	—19	—10	0	10
48.0	—135	—128	—120	—113	—105	—97	—89	—81	—73	—64	—55	—47	—38	—28	—19	—10	0
48.5	—144	—137	—129	—122	—114	—106	—98	—90	—82	—73	—65	—56	—47	—38	—29	—19	—10
49.0	—153	—146	—138	—131	—123	—115	—107	—99	—91	—83	—74	—66	—57	—48	—39	—29	—20
49.5	—162	—155	—147	—140	—132	—124	—117	—109	—100	—92	—84	—75	—66	—57	—48	—39	—30
50.0	—171	—164	—156	—149	—141	—134	—126	—118	—110	—102	—93	—85	—76	—67	—58	—49	—39

Batch ..... 315 gallons at 50° Brix

Cut-back juice ..... at 14.6° Brix

How much cut-back juice is required to reduce the Brix of the batch to 45.0°?

From Table 3, Q for the batch, $Q_b = -93$ lbs.

From Table 1, Q for the cut-back juice, $Q_j = 487$ lbs.

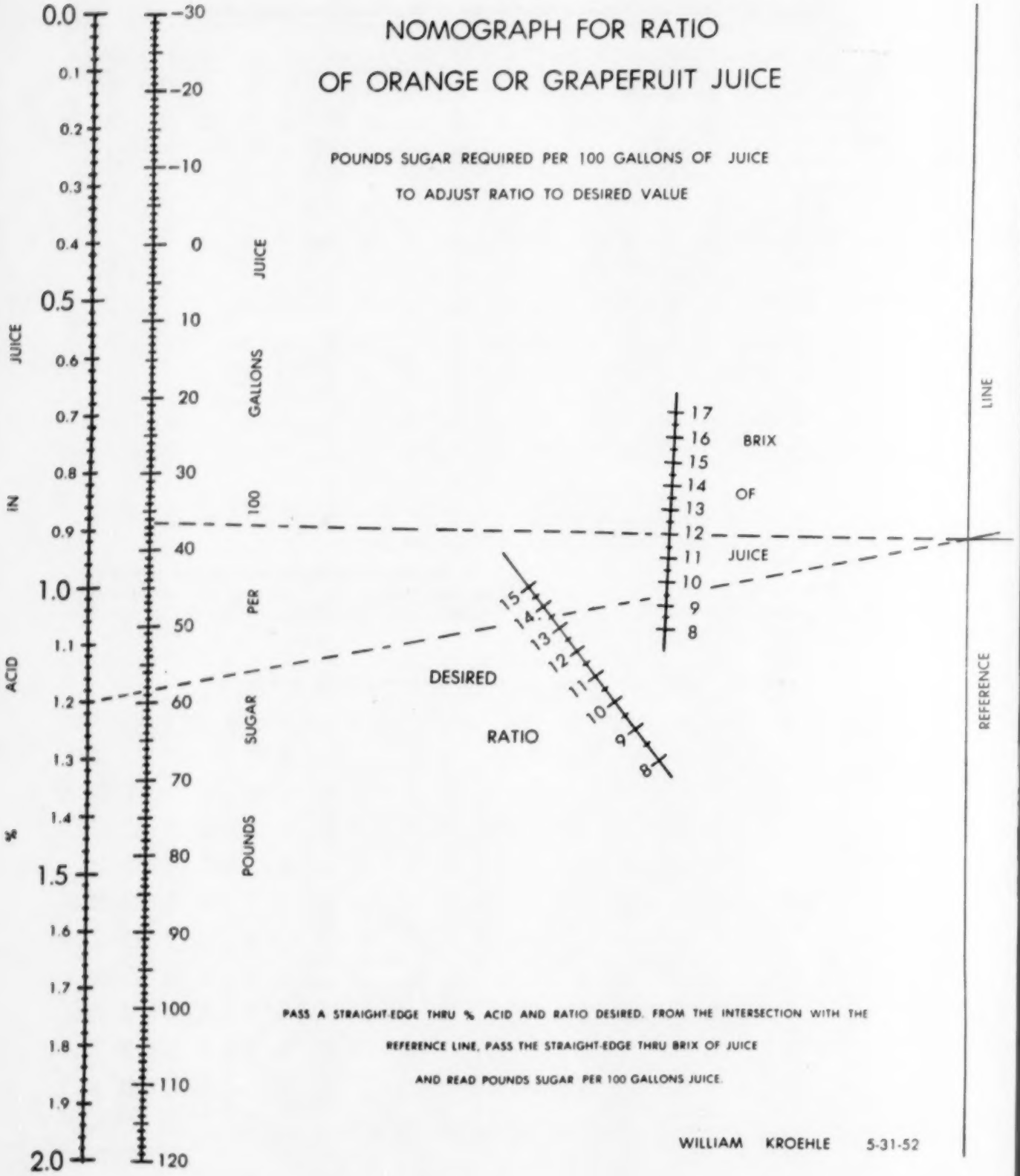
Hence $G_j = G_b\left(-\frac{Q_b}{Q_j}\right) = 315 \times \frac{93}{487} = 60$ *gals.* cut-back juice.

II. Proportions of ingredients required to produce any desired Ratio. If we have one juice with a Ratio higher than the desired value, and another juice whose

TABLE 4

Values of P_b = pounds sugar required to adjust the ratio of 100 gallons of batch to 13.0

Brix of batch	% Acid in Batch															
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5
40.0	—10	3	16	28	41	54	67	79	92	105	118	130	143	156	169	181
40.5	—15	—2	11	24	36	49	62	75	87	100	113	126	139	151	164	177
41.0	—20	—7	6	19	32	44	57	70	83	96	108	121	134	147	160	172
41.5	—25	—12	1	14	27	39	52	65	78	91	104	117	129	142	155	168
42.0	—30	—17	—4	9	22	35	48	60	73	86	99	112	125	138	150	163
42.5	—35	—22	—9	4	17	30	43	56	68	81	94	107	120	133	146	159
43.0	—40	—27	—14	—1	12	25	38	51	64	77	89	102	115	128	141	154
43.5	—45	—32	—19	—6	7	20	33	46	59	72	85	98	111	124	136	149
44.0	—50	—37	—24	—11	2	15	28	41	54	67	80	93	106	119	132	145
44.5	—55	—42	—29	—16	—3	10	23	36	49	62	75	88	101	114	127	140
45.0	—60	—47	—34	—21	—8	5	18	31	44	57	70	83	96	109	122	135
45.5	—65	—52	—39	—26	—13	0	13	26	39	52	65	78	91	105	118	131
46.0	—70	—57	—44	—31	—18	—5	8	21	34	47	60	74	87	100	113	126
46.5	—76	—63	—49	—36	—23	—10	3	16	29	42	56	69	82	95	108	121
47.0	—81	—68	—55	—41	—28	—15	—2	11	24	37	51	64	77	90	103	116
47.5	—86	—73	—60	—47	—33	—20	—7	6	19	32	46	59	72	85	98	111
48.0	—91	—78	—65	—52	—39	—25	—12	1	14	27	41	54	67	80	93	107
48.5	—97	—84	—70	—57	—44	—31	—17	—4	9	22	36	49	62	75	89	101
49.0	—102	—89	—76	—62	—49	—36	—22	—9	4	17	31	44	57	70	84	97
49.5	—107	—94	—81	—68	—54	—41	—28	—14	1	12	26	39	52	65	79	92
50.0	—113	—99	—86	—73	—59	—46	—33	—19	—6	7	21	34	47	61	74	87


NOMOGRAPH FOR RATIO
OF ORANGE OR GRAPEFRUIT JUICE
POUNDS SUGAR REQUIRED PER 100 GALLONS OF JUICE
TO ADJUST RATIO TO DESIRED VALUE
% ACID IN JUICE
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
POUNDS SUGAR PER 100 GALLONS JUICE
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
BRIX OF JUICE
17
16
15
14
13
12
11
10
9
8
DESIRED RATIO
15
14
13
12
11
10
9
8
REFERENCE LINE
PASS A STRAIGHT-EDGE THRU % ACID AND RATIO DESIRED. FROM THE INTERSECTION WITH THE REFERENCE LINE, PASS THE STRAIGHT-EDGE THRU BRIX OF JUICE AND READ POUNDS SUGAR PER 100 GALLONS JUICE.
WILLIAM KROEHLE 5-31-52

Ratio is lower, they may be mixed to produce the desired Ratio. The argument is the same as in the case of Brix. Hence, gallons of added juice, $G_2 = G_1\left(-\frac{P_1}{P_2}\right)$, where the negative sign again appears because, as in the case of Brix, either the numerator or the denominator represents a "negative sugar" requirement.[f]

[f] Analytically, the weight of Acid in 100 gallons of juice is wA. For a desired Ratio of R_d, the weight of solids must then be wR_dA. Since the weight of juice solids is wB, the weight of sugar required to adjust the Ratio of 100 gallons is $P = wR_dA - wB$, or $P = w(R_dA - B)$.

For a mixture of two juices,

$$R_d = \frac{G_1w_1B_1 + G_2w_2B_2}{G_1w_1A_1 + G_2w_2A_2},$$

by definition. Solving for G_2 we obtain:

$$G_2 = G_1\frac{w_1(B_1 - R_dA_1)}{w_2(R_dA_2 - B_2)}.$$

The numerator of the fraction is the negative of P for juice$_1$, while the denominator is simply P_2. Therefore,

$$G_2 = G_1\left(-\frac{P_1}{P_2}\right).$$

Since Ratio is a function of two variables, namely Brix and Acid, it would be necessary to construct a table of P values for each desired Ratio if the method is to be completely flexible. To obviate this, two simple nomographs, one for single-strength juice and one for concentrate, have been constructed to give the value of P for any commonly desired Ratio.[g] A nomograph for the range of finished concentrate was not prepared since for this range the Ratio 13.0 was the only one commonly desired. Table 4 gives the values of P for the range 40 to 50° Brix and for a desired Ratio of 13.0. Problems are solved in a manner entirely analogous to those involving Brix.

[g] The nomograph is derived by converting the formula $P = w(R_dA - B)$ into a more suitable expression by means of the following empirical relations which, while not exact, are sufficiently accurate for practical use. Taking 8.33 lbs. as the weight of 1 gal. of water and 0.075 gal. as the volume of 1 lb. of sugar, the weight per gallon and the Brix of the syrup obtained by dissolving S pounds of sugar in 1 gallon of water are, respectively:

$$w = \frac{8.33 + S}{1 + 0.075S}, \quad \text{and} \quad B = \frac{100S}{8.33 + S},$$

both approximately.

Eliminating S between these two equations, we obtain

$$B = \frac{100w - 833}{0.375w}.$$

Substituting this expression for Brix into the equation for P and collecting terms, we find: $P = 2222 - w(266.7 - R_dA)$. This formula may be solved by a two-step N nomograph, in which the first step gives the product of R_d times A, and the second step multiplies the quantity $(266.7 - R_dA)$ by w, the additive numerical constants being taken care of by the placing of the zeros of the scales. The error introduced by the empirical substitution is greatly reduced by plotting the points for w (labeled as the corresponding Brix) by means of values of P calculated from the fundamental formula $P = w(R_dA - B)$.

III. Proportions of ingredients required to produce any desired Brix and Ratio simultaneously.

(a) *Using two juices and sugar.* From the definitions of the symbols used, the weight of sugar required to adjust the Brix of the batch to the desired value is

$$S_{Brix} = G_c\frac{Q_c}{100} + G_j\frac{Q_j}{100}.$$

Similarly, the weight of sugar required to adjust the Ratio of the batch to the desired value is

$$S_{Ratio} = G_c\frac{P_c}{100} + G_j\frac{P_j}{100}.$$

Now, the sugar added must adjust both the Brix and the Ratio simultaneously, and it will do so if the proper proportion of cut-back juice to concentrate is used. In other words, the proportion of cut-back juice must be so chosen that the total weight of sugar required to adjust the Brix is equal to the total weight of sugar required to adjust the Ratio, i.e., so that $S_{Brix} = S_{Ratio}$. That is, $G_c\frac{Q_c}{100} + G_j\frac{Q_j}{100} = G_c\frac{P_c}{100} + G_j\frac{P_j}{100}$

Solving for G_j, we find $G_j = G_c\frac{P_c - Q_c}{Q_j - P_j}$.

Note. Q_c always, and sometimes P_j, will be negative. In such cases, the numerical value must be added.

In order to speed the calculation, a special nomograph has been constructed for the expression $\frac{P_c - Q_c}{Q_j - P_j}$ by again using approximate empirical formulas based on certain simplifying assumptions with respect to solutions of sugar in water.[h] The nomograph presented for

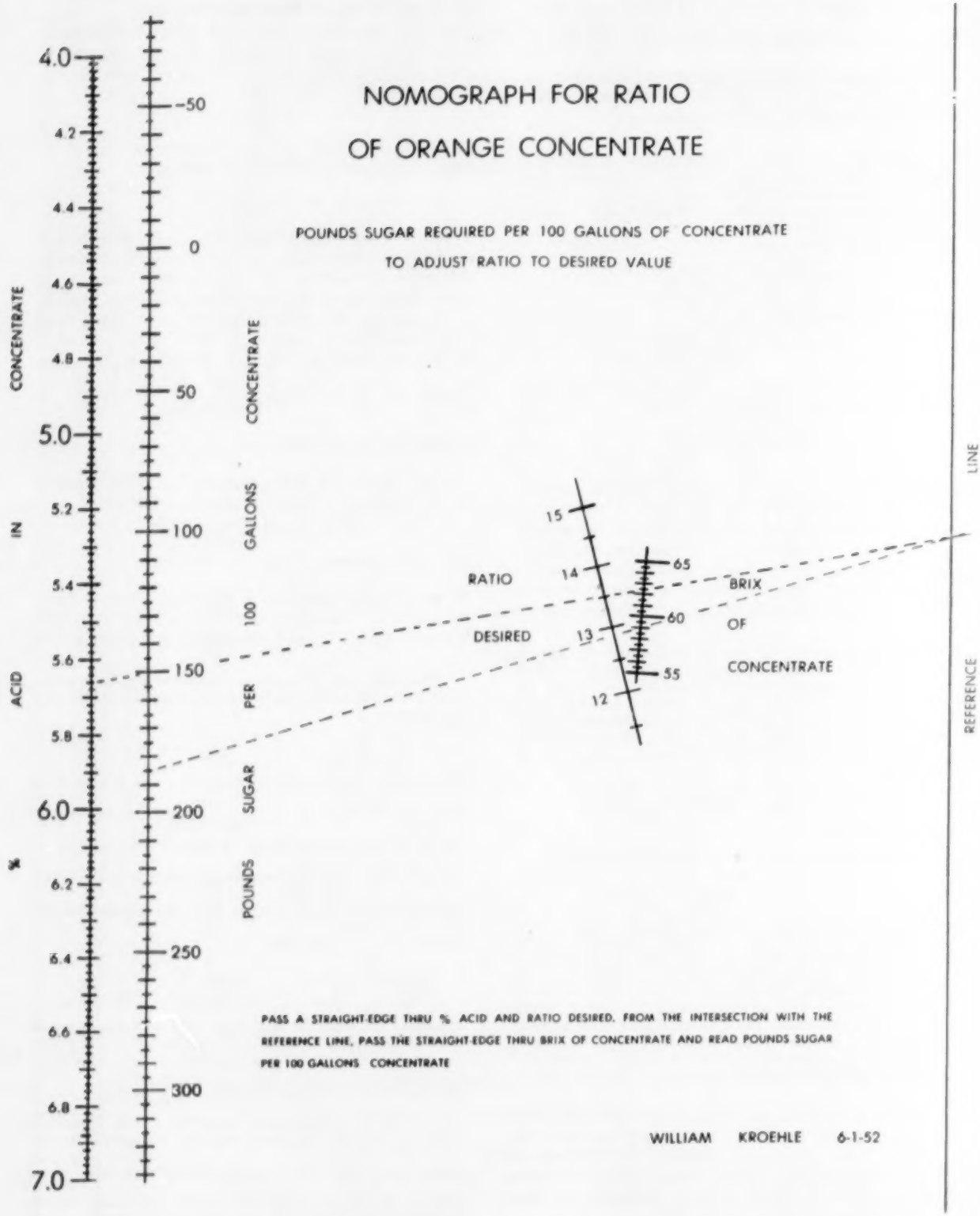
[h] Dissolving S lbs. of sugar in 1 gallon of water, the weight of solids per gallon, the weight of syrup per gallon, and the Brix are, respectively:

$$s = \frac{S}{1 + 0.075S}, \quad w = \frac{8.33 + S}{1 + 0.075S}, \quad \text{and} \quad B = \frac{100s}{w}.$$

Eliminating S between the equations for s and w gives $w = 8.33 + 0.375s$. Hence $B = \frac{100s}{8.33 + 0.375s}$. By replacing P_c and Q_c in the formula under discussion with $w_c(R_dA_c - B_c)$ and $100w_c\frac{B_d - B_c}{100 - B_d}$ respectively, substituting the empirical values of w and B in terms of s, and remembering that % Acid $= \frac{°\text{Brix}}{\text{Ratio}}$, we obtain

$$\frac{P_c - Q_c}{100} = \left(\frac{R_d}{R_c} + \frac{0.075s_d}{1 - 0.075s_d}\right)s_c - \frac{s_d}{1 - 0.075s_d}.$$

Although formidable in appearance, this expression may be solved in one operation by an N nomograph, since for any given desired Brix the two fractions containing s_d are constants and the expression is therefore essentially $\frac{f(B_c)}{f'(R_c)}$. $Q_j - P_j$ may be replaced by a similar expression which may be solved by a similar nomograph. By setting these two nomographs at right angles to each other with a common origin, the quotient $\frac{P_c - Q_c}{Q_j - P_j}$ becomes the tangent of the angle formed by joining the two solutions, which may be conveniently registered on the arc of a


NOMOGRAPH FOR RATIO
OF ORANGE CONCENTRATE
POUNDS SUGAR REQUIRED PER 100 GALLONS OF CONCENTRATE
TO ADJUST RATIO TO DESIRED VALUE
% ACID IN CONCENTRATE
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0
6.2
6.4
6.6
6.8
7.0
-50
0
50
100
150
200
250
300
POUNDS SUGAR PER 100 GALLONS CONCENTRATE
RATIO DESIRED
15
14
13
12
65
60
55
BRIX OF CONCENTRATE
REFERENCE LINE
PASS A STRAIGHT-EDGE THRU % ACID AND RATIO DESIRED. FROM THE INTERSECTION WITH THE REFERENCE LINE, PASS THE STRAIGHT-EDGE THRU BRIX OF CONCENTRATE AND READ POUNDS SUGAR PER 100 GALLONS CONCENTRATE
WILLIAM KROEHLE 6-1-52

circle with the common origin as a center. Although this construction involves empirical relations which are not exact, the fact that the quantity sought is the quotient of two differences reduces the error to less than 1% by actual calculation.

a desired Ratio of 13.0 is a combination of the 5 nomographs obtained for the 5 integral values of desired Brix from 42° to 46° inclusive, with the points for the same Ratio joined.

Consider as an example:

Concentrate—130 gals. at 59.0° Brix, 5.36% Acid (11.0 Ratio)
Cut-back juice—14.0° Brix, 1.17% Acid (12.0 Ratio)
Desired Batch—44.0° Brix, 13.0 Ratio
How much cut-back juice and sugar are required?

The construction for this problem is shown on the nomograph just described, entitled "Nomograph for Cut-back Juice." This shows 87 gals. cut-back juice per 100 gals. concentrate, hence for the given problem we have $130 \times \frac{87}{100} = 113$ *gals.* cut-back juice required.

A special advantage of this nomograph is the fact that once the volume of cut-back juice is known, the individual P values are not needed, since the sugar requirement may be calculated as follows:

From Tables 1 and 2, respectively, $Q_j = 471$ lbs. and $Q_c = -286$ lbs. Then $S = G_c \frac{Q_c}{100} + G_j \frac{Q_j}{100} = 130 \times \frac{-286}{100} + 113 \times \frac{471}{100} = 160$ *lbs.* sugar. As an exercise, the reader may check this solution by finding the P values and substituting these and the Q values in the original formula.

(b) *Using three juices or any three suitable materials.*

The problem of blending 3 juices or other suitable materials to a specified Brix and Ratio simultaneously can best be solved by a direct graphic method. The following problem is assumed.

Given 250 gallons evaporator
concentrate ..... at 58.0° Brix, 4.80% Acid
cut-back juice ..... at 12.0° Brix, 1.00% Acid
juice syrup[1] ..... at 60.0° Brix, 0.60% Acid
Desired batch (13.0 Ratio) to be 43.0° Brix, 3.31% Acid
How much cut-back juice and syrup are required?

Referring to Figure 1, the degrees Brix is plotted on the vertical axis and the percent Acid on the horizontal. Join the points representing the cut-back juice and the juice syrup by a straight line, and prolong the line joining the concentrate with the desired batch to meet the juice to syrup line at X. It can be shown[1] that X represents a particular mixture of juice syrup and cut-back juice such that mixing the given concentrate with X will produce the desired batch. This hypothetical procedure simplifies the calculations, but once the amounts are known, the order of mixing is inconsequential. The formulas are $G_j = G_c \frac{w_c}{w_j}\left(\frac{B_c - B_d}{B_d - B_x}\right)\left(\frac{B_s - B_x}{B_s - B_j}\right)$, and $G_s = G_c \frac{w_c}{w_s}\left(\frac{B_c - B_d}{B_d - B_x}\right)\left(\frac{B_x - B_j}{B_s - B_j}\right)$, where w = density of material, lbs. per gal. Time and effort may be saved by noting that the second fraction and the denominator of the third are identical, respectively, in both formulas. If the differences in Brix are small, corresponding formulas involving % Acid may be used.

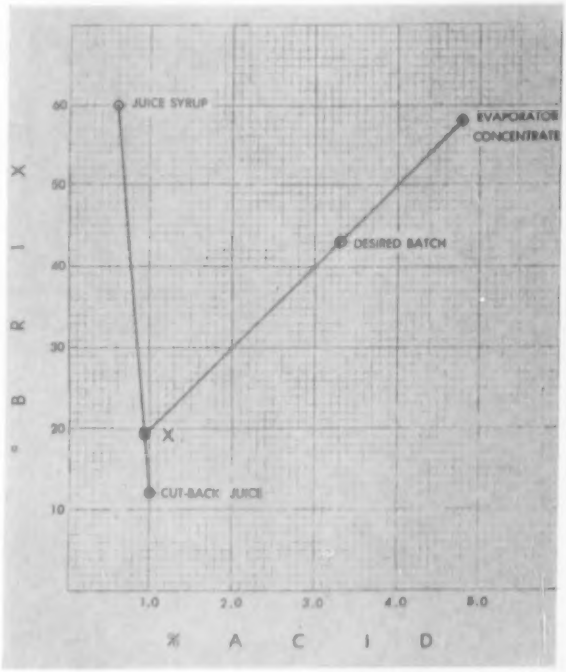


Figure 1. General graphic solution for mixing any three materials.

the weight of the material and the subscripts j, s, and m refer to the juice, syrup, and mixture, respectively. Hence, $\frac{W_j}{W_s} = \frac{B_s - B_m}{B_m - B_j}$. Similarly, $\frac{W_j}{W_s} = \frac{A_s - A_m}{A_m - A_j}$ for the Acid. That is, the weights of the constituents are inversely proportional to the Brix or % Acid differences between the constituents and their mixture. Also,

$$\frac{B_s - B_m}{B_m - B_j} = \frac{A_s - A_m}{A_m - A_j} \text{ or } \frac{B_s - B_m}{A_s - A_m} = \frac{B_m - B_j}{A_m - A_j}.$$

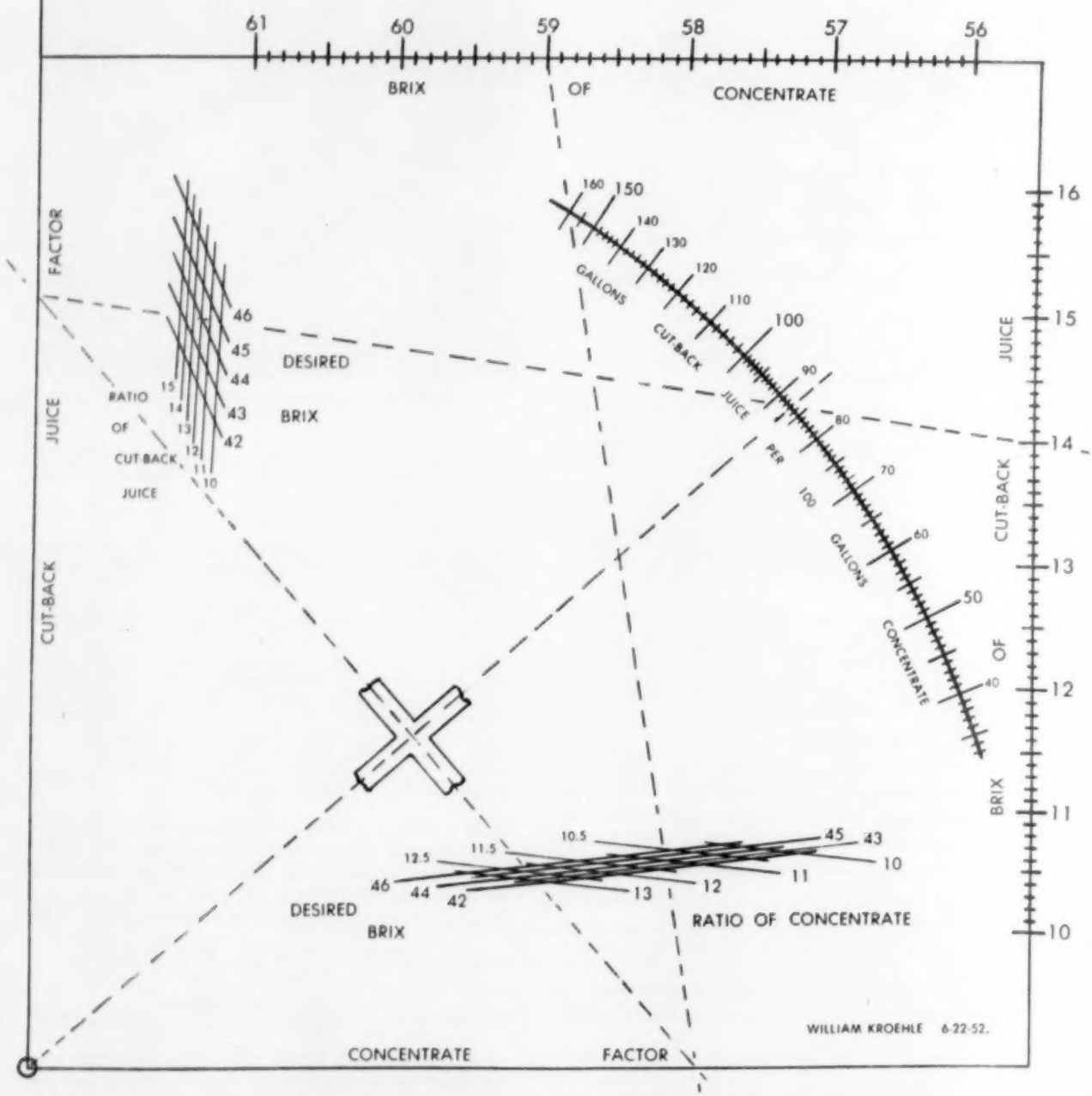
This states that the slope of a straight line from any given mixture to either one of the constituents is equal to the slope of a straight line from the mixture to the other constituent. *In other words, all mixtures of two materials lie on the straight line joining those materials.* Therefore X represents a mixture of the given cut-back juice and juice syrup, and the desired batch is a mixture of the given concentrate with X. The given formulas are then derived by composition.

[1] For, total solids in the mixture = solids in juice + solids in syrup.
That is, $(W_j + W_s)\frac{B_m}{100} = W_j \frac{B_j}{100} + W_s \frac{B_s}{100}$, where W is

[1] Made by dissolving sugar in single-strength juice.

NOMOGRAPH FOR CUT-BACK JUICE

GALLONS CUT-BACK JUICE REQUIRED PER 100 GALLONS EVAPORATOR CONCENTRATE
TO PRODUCE THE DESIRED BRIX AFTER THE ADDITION OF ENOUGH SUGAR TO RAISE THE RATIO TO 13.0



LAY A STRAIGHT EDGE THRU THE RATIO OF CONCENTRATE ON THE PROPER DESIRED BRIX LINE AND THRU BRIX OF CONCENTRATE.
MARK THE INTERSECTION WITH THE CONCENTRATE FACTOR LINE. IN A SIMILAR MANNER FIND AND MARK THE CUT-BACK JUICE FACTOR.
LAY A RIGHT-ANGLE CROSS WITH ONE ARM THRU THE TWO FACTORS AND THE OTHER ARM THRU 0, AND READ GALLONS CUT-BACK JUICE ON THE ARC

For the materials in the given problem, conventional tables show $w_c = 10.630$ lbs./gal., $w_j = 8.724$ lbs./gal., and $w_s = 10.727$ lbs./gal. From Figure 1 the Brix of the mixture X is 19.3°. Substituting these values in the formulas gives:

$$G_j = 250 \times \frac{10.630}{8.724} \times \frac{58.0 - 43.0}{43.0 - 19.3} \times \frac{60.0 - 19.3}{60.0 - 12.0} =$$

163 gals. cut-back juice, and

$$G_s = 250 \times \frac{10.630}{10.727} \times \frac{58.0 - 43.0}{43.0 - 19.3} \times \frac{19.3 - 12.0}{60.0 - 12.0} =$$

23.8 gals. syrup.

This method is completely general. The graphic construction to locate X is equivalent to the solution of a pair of simultaneous equations in two unknowns. A step-wise variation of the method is extremely useful in correcting off-batches, since in such cases the points involved usually fall within the range of the tables of this article and the simple proportions $-\frac{Q_1}{Q_2}$ may be used instead of the quotients of Brix or Acid differences.

Given: 315 gals. batch at 45.3° Brix, 3.10% Acid.
Concentrate at 57.2° Brix, 5.25% Acid,
Cut-back juice at 12.6° Brix, 1.20% Acid, and
Sugar are available for correction.

What must be added and how much to correct the batch to 42.5° Brix, 3.15% Acid?

The addition of any given material alters the batch along the line between that material and the batch. The materials needed in any given case are determined by the construction found necessary to arrive at the batch by the successive application of this principle. With a little practice, the construction may be visualized in advance—a valuable feature of the graphic method.

Referring to Figure 2, plot the points representing the given batch, the desired bacth, the cut-back juice and the concentrate, respectively. Draw the batch to cut-back juice line, then the concentrate to desired batch line prolonged to intersect the first line at X. X is found to lie at 40.0° Brix. It is assumed that cut-back juice is first added to reduce the Brix to 40.0°, and then concentrate is added to raise the Brix to the ultimately desired value of 42.5°. The construction automatically takes care of the Ratio. The reverse order of addition would require a different construction, but would give the same final results.

For a temporary desired Brix of 40.0°,

$$G_j = G_b\left(-\frac{Q_b}{Q_j}\right) = 315\left(-\frac{-89}{399}\right) =$$

70 gals. cut-back juice.

For the final step,

$$G_c = G_x\left(-\frac{Q_x}{Q_c}\right) = 385\left(-\frac{43}{-271}\right) =$$

61 gals. concentrate.

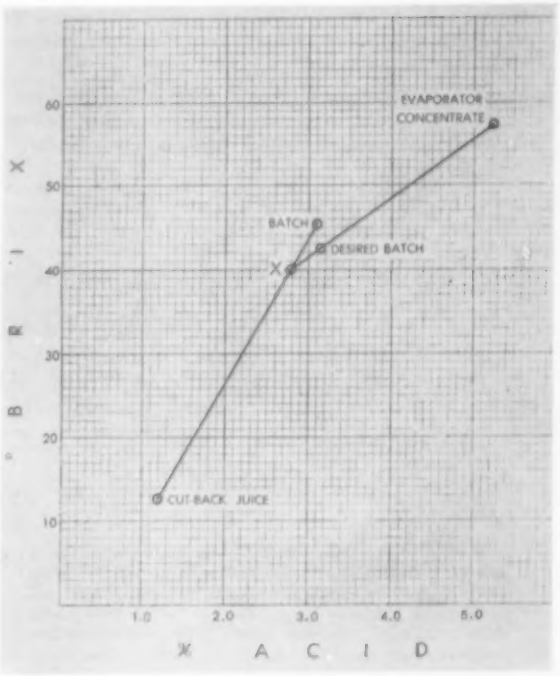


Figure 2. Graphic method for adjusting batch.

Theoretically it is never necessary to add more than two materials to correct a batch with respect to two variables (Brix and Ratio), but a complication arises when sugar is needed in an amount greater than will dissolve in the cut-back juice required (if any is required), since it is very difficult and time-consuming to dissolve it in cold concentrate. This case is resolved by either (a) making a preliminary calculation of the effect of adding an arbitrary amount of juice; or (b) adding a small batch in the approximate proportions of the original batch in addition to the calculated corrections. The details of these maneuvers are left to the reader.

Acknowledgments

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A Method for the Comparison of Consistency in Potato Granule Samples Appraised at Different Times[a]

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(Manuscript received September 7, 1954)

A method is described by which samples of potato granules, appraised at different times, can be compared. In this method groups of four samples of reconstituted granules are ranked for rubberiness along with two coded controls. (The "high control" is less rubbery than the "low control.") Each unknown is placed in a category relative to these controls. The categories are based on an arbitrary interval around each control and are not affected by the number of judgments or their variability. Five categories are possible: A, less rubbery than high control; B, like high control; C, between high and low controls; D, like low control; and E, more rubbery than low control.

A trained panel appraised selected samples several times in different groups to see if they would fall into the same category repeatedly. In thirty reappraisals, ten samples shifted by one category. When controls were selected that were not very different in consistency, shifts in category were more frequent than when differences were larger.

Most workers involved in the subjective evaluation of flavor and texture of food assume differences among samples can be judged on a comparative but not on an absolute basis. This assumption is particularly important where small differences are involved. Judges are usually not relied upon to remember from one session to the next and to repeat their scores on a discrete scale. Therefore it is difficult to interpret experiments involving large numbers of samples, or samples appraised at different times.

Incomplete blocks and other experimental designs *(5, 11)* offer some solution when many samples need to be compared. The dilution method has been used to study progressive flavor changes in stored eggs *(3)*, and to determine relative flavor stability of two types of dried eggs *(10)*. Kline *et al. (14)* used "delay testing" to compare samples from different storage periods by keeping each sample, after its experimental storage period ended, at a low temperature until all storage had been completed.

It has been stated that "the availability of good reference standards would do more than anything else to improve the accuracy of palatability testing" *(6)*. A labeled control has been employed to stabilize scores or to serve as a reference *(2, 3)* and one coded control has often been included with the unknowns. Sharp *et al. (17)* adjusted scores of stored eggs to the shifting scores for a coded fresh egg standard. Handschumaker *(9)* included five standards in a series of six samples. But these methods were not adequate for many types of experiments and there was a need for a more effective way to compare samples from different experiments. Bliss *et al. (1)* discussed the possibility of using two standards in a system similar to the one described here.

The problem was especially acute at this laboratory where the relationship of process variables to the quality of potato granules was being studied. The achievement of satisfactory texture was considered the most important quality problem. Many experimental samples were being produced, but at the time there was no way of comparing their textural qualities. An objective method *(15)* was developed to follow changes in potato granules, but it was not found to correlate well with subjective measurements of texture over a wide range of samples. Therefore a system was devised which made it possible to compare samples judged at different times by placing each unknown in one of five categories. This was done by ranking a series[b] of experimental samples in order of rubberiness along with two coded controls which differed in rubberiness. The less rubbery control was designated as the high control, the more rubbery one was the low control. Samples were assigned to categories according to mean rank. The categories were:

A—less rubbery than high control
B—like high control
C—between high and low control
D—like low control
E—more rubbery than low control

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, Calif., June, 1954.

[b] The terms series and groups are used interchangeably, and refer to four to six samples appraised together.

These categories were represented by intervals along a ranking scale. In this way any sample could be compared with any other ranked at a different time by comparing their relative categories.

The validity of this method of comparison depends on evidence that a sample would fall into the same category repeatedly, regardless of other samples appraised with it. For this to be true the controls would have to be stable (in texture in this case) over the period of their use. In order to obtain this evidence samples from several sources representing a wide range of qualities were appraised with the controls and then regrouped and appraised again. Possible changes in the controls on storage were studied indirectly by appraising samples stored at different temperatures.

In potato granule research an additional problem was imposed by the importance of detecting relatively small differences. This was due to the add-back method of production *(15)* in which it was often necessary to examine a product soon after a change in raw material or processing method, before the full effect of the change could be seen in the product.

PROCEDURES

Sample preparation. Before a standard preparation procedure was established, it was necessary to determine whether a change in preparation conditions would affect different kinds of granules in the same way. If it did, an arbitrary selection of procedure might prove to be a disadvantage to certain samples. In one experiment the variables were water temperature, 160° F. (71.1° C.) and 180° F. (82.2° C.) and proportion of granules to water, 1:4.6 and 1:5.0. Three kinds of raw material were selected, each to make up a separate series including the 4 variable conditions. These were judged for mealiness (in the mouth), and pastiness and rubberiness (tested with a fork on a plate). The same trends were apparent in each series, namely: temperature of 180° F. (82.2° C.) always resulted in potatoes that were less mealy, more pasty and more rubbery than those reconstituted at 160° F. (71.1° C.). A lower proportion of water always resulted in more rubbery texture.

In an experiment on the effect of holding time using two kinds of granules, no significant differences were found between potatoes held 15 or 40 minutes, but both were slightly more rubbery than samples with "no" holding.

Effect of stirring was studied by preparing 2 kinds of potatoes with 20, 60, or 120 strokes of the fork in 10, 30, or 60 seconds, respectively. The results showed a slight tendency for decreased rubberiness with increased stirring.

A trial of the reproducibility of mixing showed that duplicate samples in a series received essentially the same average rank repeatedly, and it was concluded that potato granules could be reconstituted uniformly.

After considering these experiments, the standard procedure for preparation of granules of 12% moisture content was decided on as follows: 50 g. of granules were added to 205 ml. of distilled water at 160° F. ± 0.5° (71.1° C.) in 10 seconds, stirring 20 strokes with a fork. The potatoes were stirred a total of 60 strokes in 30 seconds and allowed to stand approximately 15 minutes before being served. The amount of water was varied for samples of different moisture content, so that the ratio of total moisture to dry solids was always 4.8 to 1.

Selection of controls. Two controls were selected to be in each half of the range of rubberiness that would be encountered in the samples tested. The controls were close enough in quality that occasionally they were not ranked in the expected order. A total of 4 controls was used throughout this work. For convenience they were labeled in order of increasing rubberiness: 1, 2, 3, and 4. The sequence of use was controls 2 and 4, 1 and 2, and 1 and 3. Changing the controls was necessary because of changes in quality of the samples to be tested and later because of browning in one control. No cross comparisons were made between series appraised with different controls.

Appraisal. At the start of this study a small panel was set up to determine the important subjective factors in the texture of mashed potatoes. After looking at many different samples, testing them in various ways and describing their texture characteristics, the list of factors to be judged was narrowed to three: mealiness, pastiness and rubberiness. Mealiness was graded separately under colored lights. Samples were recoded for judging the other two factors. If color differences were present, food coloring was added to the water before reconstitution. Results from several series showed that fewer differences were noted in mealiness and pastiness than in rubberiness but when differences were present, they always showed the same pattern. Since pastiness and rubberiness were difficult to judge independently, judgments were confined to mealiness and rubberiness for the next phase of the work. Figure 1 shows the relation

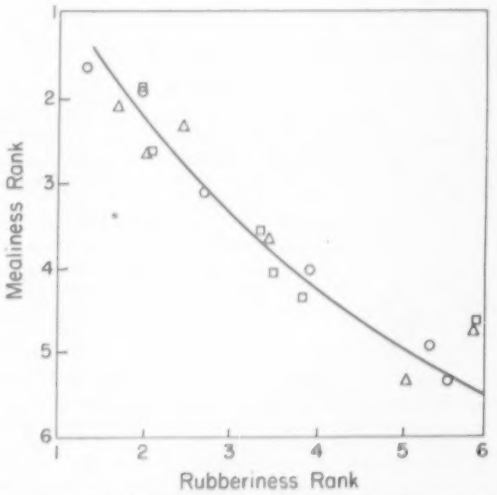

Figure 1. Relationship between rubberiness and mealiness in three series.
Rank 1 = *most mealy;* rank 6 = *least mealy.*
Rank 1 = *least rubbery;* rank 6 = *most rubbery.*

between the 2 factors in 3 series, and although the correlation was by no means perfect, it was considered adequate. Therefore it was decided to limit future judgments to rubberiness, because all work showed that differences in mealiness and pastiness were reflected and often magnified in rubberiness.

The final appraisal procedure was as follows: Each series was judged 3 or 4 times by 7 to 16 judges. This will be called "one" appraisal. In most cases several series were run concurrently and randomized as an extra precaution so that the judges did not know the exact nature of the samples they were testing. A judge received a tray with six 3 x 4 in. glass slides, each containing about a tablespoon of potato. All 6 samples were coded; 2 were controls, 4 were unknowns. The judge manipulated the samples with a fork and moved the slides in order to rank them for rubberiness. Because manipulation affected the texture, the judges were instructed to treat all samples alike. Rank "1" represented the least rubbery sample. Ties were not permitted; so judges used as many ranks as there were samples.

Analysis. For comparison between samples in different series each sample was placed in a category. Categories B, C, and D were arbitrarily made equal in size. This was done by determining the difference in mean rank between the two controls, and placing one-fourth of this difference on either side of each control. Any part of the range remaining formed categories A and E. Samples were automatically placed in categories according to their mean ranks. Figure 2 gives two examples of placing samples in categories and demonstrates the flexibility of the

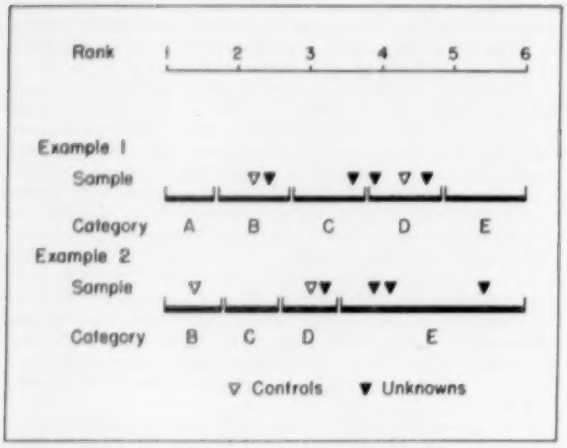

Figure 2. Graphic demonstration of assignment to categories.

position of controls and categories on the range of ranks. In example 1 the average ranks of the unknowns fell near or between the average ranks of the controls, giving a fairly symmetrical picture. In example 2 all unknowns received average ranks higher than either control, with the result that category E is quite large and, there is no category A.

In order to get full value out of the data, it was desirable to determine significant differences between samples *within* a series. For most of the series, the analysis of variance was performed with minor modifications in the degrees of freedom. A least significant difference of the Scheffé type *(16)* was also calculated.*

* Details of the analysis are: In most series the variances (squares of the standard deviations) of the samples were relatively homogeneous and it was possible to perform the analysis of variance. (The criterion of homogeneity for a series was that the highest variance of a sample was not more than 3 times the lowest variance.) The series with non-homogeneous variances were treated by a technique involving a multi-variate normal assumption *(13)*. This approach could have been used for all series, but the analysis of variance is simpler and more sensitive where it is applicable.

The analysis of variance was performed on the ranks as such, since there appeared to be no advantage in converting to "Z scores" *(7)* in view of the nature of the series (a small number of treatments with large differences among treatments).

The sources of variation in the analysis were: *treatment, treatment* × *judge interaction,* and *treatment* × *replication interaction.* Consistency of judges and replications was appraised from the interactions. A modification in the degrees of freedom was necessary to account for the fact that in ranking, the sum of any set of ranks is constant and therefore all the observations are not independent. The total degrees of freedom was obtained from the product of (number of treatments—1) × number of judges × number of replications.

A new least significant difference of the Scheffé type was used because it makes possible the comparison of all pairs and combinations of treatment means, whereas the usual L.S.D. employing a "t" table is inadequate for making many comparisons. For investigating relationships among treatment means this new L.S.D. takes the following form:

$$\sqrt{\frac{\text{Mean square of remainder} \times 2 \times (\text{number of treatments} - 1) \times \text{F value}}{\text{Number of judgments}}}$$

F value is taken at the desired level of probability for

$$\frac{\text{degrees of freedom of treatment}}{\text{degrees of freedom of remainder}}$$

REPRODUCIBILITY OF METHOD

Effect of storage on texture. For the method to function properly, i.e., for samples to fall into the same category repeatedly, the controls would have to remain essentially unchanged in texture over the period of their use. This was studied indirectly by storing 2 different samples, X and Y, at 4 temperatures for 6 or 5½ months and then ranking them with 2 controls (Table 1).

TABLE 1

Effect of storage temperature on texture

Sample X stored 6 months			Sample Y stored 5½ months		
Storage temperature ° F.	Rank [1, 2]	Category	Storage temperature ° F.	Rank [1, 2]	Category
High control	2.2	(B)	95°	1.6	A
100°	2.4	B	High control	2.9	(B)
77°	3.6	C	77°	3.2	B
37°	3.9	D	37°	3.8	C
Low control	4.3	(D)	—30°	4.5	D
—30°	4.6	D	Low control	4.9	(D)
L.S.D. 5%[4]	1.2			.9	

[1] Rank 1 = *least rubbery;* rank 6 = *most rubbery.*
[2] Nine judges, 4 replications (data in this column are the same as those presented graphically in the first example in Figure 2).
[3] Eleven judges, 4 replications.
[4] Least significant difference of the Scheffé type *(16)* and described above.

The category of sample X before storage was C. Unfortunately, sample Y was not ranked by a full panel before storage but indications are that its category was also C. For the stored samples there was a trend for decreased rubberiness as storage temperature increased. (The L.S.D. shows a significant difference between the highest temperature sample and the other three in both series, as well as a difference between 77° F. (25° C.) and —30° F. (—34.4° C.) for sample Y.) This decreased rubberiness at 100° F. (37.8° C.) and 95° F. (35° C.) probably reflected some change in the starch which resulted in decreased rehydration. It is difficult to tell from these limited data, which of the stored samples is most nearly like the original material. Thirty-seven degrees F. (2.8° C.) was chosen as the most suitable storage temperature for controls, partly because some browning may occur at 77° F. (25° C.). Since the changes on storage are gradual, any selection of the useful life of a control would be arbitrary. It was concluded that if controls are kept in refrigerated storage, comparisons could be made over periods up to 6 months.

Reproducibility of category assignment. In order to test whether a sample would fall into the same category repeatedly, various samples were appraised several times in different combinations. Three groups of granules, containing 4 samples each were selected, 2 groups were from commercial sources and one was from this laboratory. They were chosen to represent a wide range of quality. First each group was ranked with controls 2 and 4. Then 4 samples from different categories and different sources were appraised again with the controls. One sample changed one category.

Additional information was obtained and tabulated in Table 2 to include the above samples and all others which were appraised more than once. Twenty-two different samples were appraised 2, 3, or 4 times for a total of 30 reappraisals. There were 10 shifts of one category.

TABLE 2

Reproducibility of category assignment

Controls	Number of samples that	
	fell into same category	shifted one category
2 and 4	7	1
1 and 2	5	6
1 and 3	8	3
Total	20	10

DISCUSSION

Even though each sample did not always fall into the same category and the samples were not completely stable, it was concluded that this method can be used to compare samples appraised at different times.

Many samples did "shift" one category, but deviation was never greater than this. Because the reproducibility of assignment to category was not perfect certain allowances were made when applying the method. For example in the series discussed here, if one sample fell in category B, it was concluded that it may be different from another sample in category C, but was almost certainly different from one in category D.

The variation in category probably would be less if differences between controls were greater. The differences between controls 1 and 2 were not large and therefore the categories represented relatively small degrees of difference. Change in category was more frequent when these two controls were used. Selection of the controls would depend partly on the "size" of the difference it was necessary to detect.

The system employed for setting up intervals is purposely arbitrary and has no relation to statistical significance. Since the investigator is equally interested in proper placement in each of the 5 categories, the setting up of categories by a least significant difference, or other statistic at a known confidence level, is unnecessary. With this system results can be compared from experiments with a widely varying number of judgments. The "length" and position of the categories will be affected by the quality of the samples judged with the controls. This is demonstrated in Figure 2. But the likelihood of a sample falling into one category repeatedly will not be influenced by the quality of the other unknowns judged with it. Whenever there is a need to determine whether a sample is significantly different from a control or from another sample, an analysis of variance can be performed and a least significant difference calculated.

An advantage of this method is its simplicity of application. Only minor calculations are necessary after the ranks are averaged.

It has several limitations. The lowest rank does not necessarily indicate "best" texture quality. For example, samples in category A although lacking rubberiness, may be too watery, and less desirable texturewise, than certain samples in category C. Thus rubberiness might be represented by a straight line, and acceptability by an inverted U or J curve. The method was designed for use as a research tool, to obtain information about the magnitude and direction of consistency changes related to processing variables. The results cannot be used as an indication of quality, except perhaps for the very rubbery samples which probably would be objectionable to the consumer public. Although it is generally accepted in the literature *(8, 18, 19, 20)* that "good" mashed potatoes are mealy, little is known about actual consumer preferences. The relative preference for mealy, dry, mashed potatoes, or creamy, "whipped" potatoes is not known. These factors, and the importance of different degrees of rubberiness and pastiness would have to be assessed through extensive consumer preference studies.

Preliminary studies showed good agreement between scores for rubberiness, pastiness and mealiness, but this does not mean that there will always be a perfect correlation. Pastiness and rubberiness were especially hard to distinguish in some samples. Firmness and wetness sometimes confused the judging. Although it was decided to rank only one factor, the total texture picture of a sample is made up of several factors. Therefore, with this type of method it is recommended that full use be made of judges' comments when interpreting data.

Another limitation of the method is that two controls must always be present and therefore a large percentage of the total effort is expended judging material of known quality. One partial solution would be to adapt this system to incomplete blocks. Then use of the categories would be limited to comparing results from different experiments. The problem is not as serious when texture rather than flavor is being judged because fatigue is not as important, and it is possible to judge a larger number of samples for texture than is feasible for flavor.

Adaptations of this method could be made for different products or for judging flavor or color. The number of unknowns, judges, replications, or controls could be varied though only two controls are presented at one time. The method could also be used in quality control work, comparing one or more production samples with two controls. After selection and repeated use of the controls, the experimenter should have a general picture of the degree of difference represented by the controls and by the five categories.

Harvey *(12)* has stated that ranking methods are not useful unless the samples to be considered can all be ranked at one assessment. This method partially overcomes his objection by providing a means of comparing samples appraised at different times. For a large number of samples that could be appraised at the same time it eliminates the necessity of using very large complete or incomplete blocks.

Acknowledgment

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Progress of Research in the United Kingdom on Fruit and Vegetable Dehydration[a]

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The overall objective in food dehydration in the United Kingdom, as elsewhere, is the production of compact stable foods which on reconstitution closely resemble the fresh material. This objective is being approached by basic research on (1) oxidative rancidity and the break-down of carotenoids; (2) the internal chemical reactions of non-enzymic browning, and (3) the factors influencing texture deterioration on processing and storage. No appreciable work has yet been done on oxidative rancidity in fruits and vegetables, but in connection with off-flavors resulting from the break-down of carotenoids advances have been made in the extraction and identification of carotenoids from tomatoes and swedes including the discovery of 6 lycopene isomers not previously reported. Work on the browning reactions has resulted in progress in the isolation and identification of primary reactants in fruit and vegetable tissues. Studies are being made of the chemical nature of the cell walls in relation to reconstitution and texture.

Applied research has largely been directed towards extending the storage life at high temperatures of vegetables dried by conventional hot air methods, by reducing the water content by varying the strip size, the drying conditions and the use of bin drying. It has been found that at low water contents the proportion of sulphur dioxide in the free state increases and remains high.

The main advance in processing in the United Kingdom has been in the development of vacuum contact plate drying. This method is versatile in that it is applicable to fruit, vegetables, meat and fish. It permits the drying of larger units of material, e.g. whole tomatoes, and the initial quality of the products has invariably been more satisfactory than those dried by conventional means.

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After the end of the 1939-1945 war, Government sponsored research and development in the dehydration of foods ceased. Both the Ministry of Food scientists and the Food Investigation Organization of the Department of Scientific and Industrial Research re-orientated their program of work to problems of reconstruction and peace-time application. By 1947, however, the international climate was such that Defense was again an unwelcome necessity and the United Kingdom Government was advised by the Commonwealth Advisory Committee on Defense Science, in common with all Governments of Commonwealth countries, that research and development on the production of stable compact foods should be resumed. This advice was adopted by the United Kingdom Government in 1948 and as a result a co-ordinated program of research and development on the dehydration of foods was agreed between the Ministry of Food and the Food Investigation Organization of the Department of Scientific and Industrial Research. The latter is concerned mainly with "background" or "basic" studies while the former undertakes responsibility in the main for the application of the results of research. For this latter purpose the Ministry of Food has built and equipped an Experimental Factory in which laboratory, pilot plant and full scale plant facilities are available for research and development in dehydration and compression (Figure 1).

The overall objective in food dehydration is the production of foods of great concentration which, when enclosed in suitable containers, will store well over a wide range of climatic conditions and which can be speedily prepared to give palatable, nutritious dishes

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Figure 1. A general view of the Ministry of Food's Experimental Factory at Aberdeen, Scotland.

closely resembling those prepared from the fresh materials. In some of these respects modern dehydrated vegetables and fruits (not to mention fish and meats) may be considered highly successful, but it must be admitted that a solution is still being sought for the problem of prolonged storage at high temperatures such as may be encountered in the tropics and many other parts of the world. Accordingly an appreciable amount of the current research work in the United Kingdom is devoted to solving this problem, particularly by investigating on the fundamental side the nature and prevention of the "browning reactions" and on the practical the production of products with yet lower and lower water contents.

BROWNING REACTIONS

The browning reactions have long been believed to be mainly caused by the degradation of the products of the so-called Maillard reaction between amino acids and sugars. In support of this was the fact, found during the war, that amino acids as estimated by electro-metric formol titration decreased rapidly in amount on heating. However, this loss of amino nitrogen is clearly not directly related to the production of brown material as this may occur at a steady rate over a long period of time while the amino acids fall rapidly to a low but steady value. Haas and Stadtman *(1)* more recently have shown that in apricot juice the Maillard reaction is responsible for part only of the brown material produced, as when the extract is separated by ion exchange resins into acidic, basic, and neutral fractions, any pair of these fractions when mixed and heated gave browning reactions.

A similar type of study has been made in the United Kingdom at the Low Temperature Research Station, Cambridge, with dried vegetables. An alcoholic extract of the vegetable was prepared and freed from carotenoids. The extract was then passed in succession through a base exchange and an acid exchange resin. The basic and acidic fractions were displaced and the three fractions so obtained concentrated and their pH values adjusted to 6.1. Aliquots were dried by themselves and also mixed in all combinations and, after equilibrating to 30% relative humidity, heated at 52° C. The brown material produced was taken up in 60% alcohol and the insoluble part, when present, was dissolved in normal sodium hydroxide, neutralized and taken up in 60% alcohol. The extinction coefficient was measured with a deep blue filter.

Dehydrated cabbage, carrot, and potato all behaved in a similar manner qualitatively and so may be described comprehensively. The only samples which browned greatly contained the basic (amino) fraction and the neutral (sugar)fraction. The basic fraction by itself browned rapidly at first but the rate of browning then slowed down and browning nearly ceased. The total brown pigment produced in this fraction was small but significant.

The addition of the acidic fraction to the basic fraction greatly increased the initial rate of browning but had little effect on the total amount of pigment produced. From this it would appear that any significant contribution to the browning of dried vegetables by a reaction between organic acids and amino acids was ruled out. When the acidic fraction was added to the combined basic and neutral fractions, there was again an increase in the initial rate of browning and also there was in the later stages a decrease in the proportion of the brown pigment that was water insoluble. Thus, although the acidic fraction did not appear to be a primary reactant it influenced both the initial rate and the course of the later stages of the browning reaction.

The combined neutral and acidic fractions browned slightly (to about 2% of the amino-sugar browning in the early stage) but the amount of browning was not a significant contribution to the total effect. Figure *2* illustrates graphically the behavior of extracts from potato.

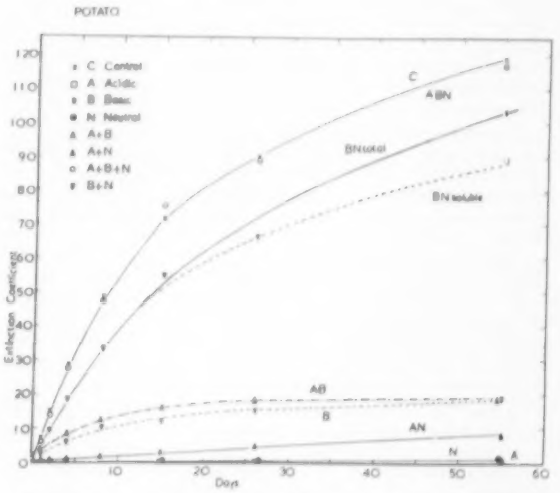

Figure 2. Rate of browning of extracts of dehydrated potato. For conditions see text.

From the results of this work it appears that the Maillard reaction is responsible for probably 95% of the browning in dried carrot, cabbage, and potato. It does not appear that any one amino acid in particular is responsible for the effect since qualitative examination of paper chromatograms of partly browned extracts after spraying with ninhydrin did not show that any one amino acid disappeared faster than the others. There was, instead, a general weakening of the intensity of all the spots.

A surprising feature of the work was the fact that the basic fraction browned when heated by itself. As judged by paper chromatography this fraction was free from sugars. Furthermore, a fraction prepared in a similar way from *fresh* carrots did not brown under similar conditions. This suggests that there is in dried carrot an intermediate of the browning reaction. This presumed intermediate must have base exchange properties and its isolation and purification is being carried out.

As a matter of interest it may be added that though the browning of extracts of the 3 dried vegetables was qualitatively similar, *quantitatively*, dried cabbage extracts varied appreciably from dried carrots and potatoes. The rates of browning of extracts of dried cabbage were much faster than those of dried carrot or potato although the pH and "total nitrogen" of the samples from all the vegetables and the sugar content of the carrot and cabbage were approximately the same. For dried cabbage the brownness produced when the progress curves begin

to level off is about 5-10 times as great as with dried carrot or potato; it is approximately proportional to its initial rate of production. Work is continuing on these striking differences in rates of browning between the different vegetables.

CAROTENOID PIGMENTS

It has been known for some time that breakdown of the carotenoid pigments in plant tissues on dehydration or storage of the dehydrated product, is responsible for some of the deteriorative changes observed.

The oxidative breakdown of beta-carotene to beta-ionone in dehydrated carrot *(5)* and the accompanying off-flavors and odors are well known. There is a possibility that the characteristic "ketchup" flavor of processed tomato preparations may also be associated with carotenoid breakdowns. Little attention, however, has been paid to possible alteration of molecular configuration and its subsequent influence on nutritive value and color. The change in color during dehydration and cooking of the swede *(Brassica rutabaga)* has been known for some time but the explanation has not been sought until recently. In recent work the pigments of the swede tissues have been extracted, separated by adsorption chromatography on alumina, and examined by ultra violet spectrophotometry. A number of previously uncharacterized poly-*cis* lycopenes have been revealed in this manner *(2)*.

Unstable poly-*cis* forms present in swedes, when subjected to such influences as heat, light and iodine, isomerize to the more stable all-trans, mono- and di-*cis* forms with a change in color from lemon yellow to orange. This color change is due to the adsorption spectrum of poly-*cis* forms being displaced some 30 mμ towards the ultra violet region of the spectrum with the all-*trans*. Cooking and dehydration have been shown to have a similar effect. In other carotenoid containing tissues such as apricot, peach, and tomato, when the all-*trans* forms predominate, the pigments isomerize with heating of the tissue to mono- and di-*cis* forms without any changes of color. If all-*trans* alpha, beta-, and gamma-carotene are present then the provitamin A potency of the tissue is reduced by this heating *(7)*.

It has been shown that during the dehydration of tomatoes there is a destruction of carotenoids by a mechanism as yet not understood *(3)*. Simultaneously there is a development of off-flavors which appears to run parallel with this pigment destruction.

PRACTICAL DEVELOPMENTS IN DEHYDRATION

Although the researches in progress should provide a broader basis of fundamental information for future application, there is still available knowledge which has not yet been fully applied. For example, it is well known that increased storage life at high temperatures may be attained by drying to low moisture contents, but conventional drying methods cannot readily produce good quality material of low moisture content. The Ministry of Food's Experimental Factory enables studies to be made of problems such as this, both on a small and a large scale.

A. Conventional air drying. The hot air drying plant at the Factory is essentially similar to that used in the Ministry's wartime production plants *(6)* apart from a modified drying tunnel system. The general plan is to load the blanched vegetables on to trays which are stacked in trolleys and dried in crossflow hot air cabinets forming, in effect, a three-stage tunnel. This system provides more flexibility in the control of drying than did the two-stage tunnel used in the United Kingdom during the war, and the drying time is now about two hours less than the wartime practice. Cabbage can be dried to 3-4% moisture content in 4½-5 hours and potato and carrot of the usual United Kingdom dimensions (strips $\frac{3}{16}$ in. x $\frac{5}{16}$ in.) to moisture contents of 6-7% in the same time. It may be mentioned that extensive storage tests of cabbage of 3-4% moisture content (gas packed in nitrogen) prepared on a commercial scale, indicate that it will remain acceptable and retain more than 200 mg./100 g. of ascorbic acid for some 8 months at 37° C. compared with 3-4 months for cabbage of 5-6% moisture content *(4)*, and one month for cabbage of 7-8% moisture content.

Bin Drying. Finishing the drying of root vegetables in bins or in deep tray through draught driers both increases the throughput of the primary driers and yields material of lower moisture content. It is, however, not yet certain that this prolonged drying in the finishing stages to achieve a moisture content of, say, 5% instead of a usual final value of, say, 7%, does not have as deleterious an effect on the storage life of the vegetable as a final relatively high moisture content, though the results of experiments made so far, and these are not many, do suggest that when potatoes of about 7% moisture content are dried down to 5% by heating at 140° F. for a further 6-8 hours, the storage life of the material at 37° C. is somewhat improved.

Reduction of Strip Thickness. A more promising method of obtaining lower moisture contents with relatively short drying periods has been to reduce the strip thickness of root vegetables to $\frac{3}{32}$ in.; moisture contents of 3.5-4% are then easily attainable.

B. Vacuum contact plate drying process. A vacuum dehydration process of Danish origin is also under development at the Experimental Factory. The main difficulty in drying under vacuum is to supply adequate heat to the material being dried owing to the slow rate of heat transfer in a vacuum. In the present process the foodstuff is spread on aluminium trays (8 x 4 ft. in the large model at the Factory), covered by sheets of aluminium of the same size as the trays, and placed in a vacuum cabinet between heating plates through which water circulates at controlled temperatures of up to 140° C. The plates can be drawn together in a concertina-like manner by a hydraulic toggle mechanism, and, as drying proceeds, the operator reduces the space between the plates in such a manner as to maintain thermal contact above and below the material being dried. Instead of merely maintaining thermal contact a certain amount of pressure may be applied by the plates on the material during drying, thus producing a modest amount of commpression (Figure 3).

The large scale equipment so far available has not lent itself to the acquisition of critical physical and engineering data, but nevertheless has enabled a comprehensive study to be made in broad outline of the potentialities of the method. It has been applied to a wide range of vegetables, fruit, meat, and fish.

By this process leafy vegetables are dehydrated in the conventional shreds; root vegetables, however, can be dried in strips or in slices. With potato it has been found possible to dry strips of considerably larger dimensions

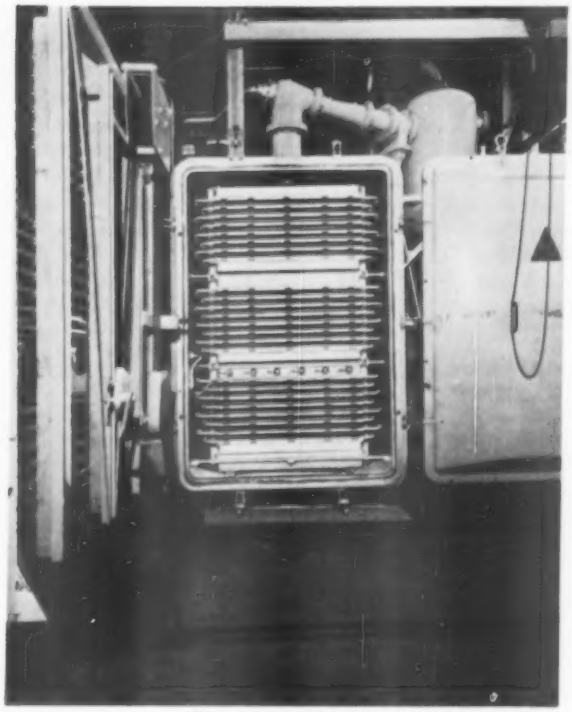

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Figure 3. A vacuum contact-plate dehydration cabinet. The foodstuff is placed on an aluminium tray, covered with a sheet aluminium lid, and inserted between the heating plates. The ends of the lids and trays can be seen in the photograph. The heating plates are in three banks of eight, accommodating 21 trays, and can be moved together to maintain thermal contact in the foodstuff as drying proceeds. A cabinet of this type holds ½ to 1 ton of foodstuff, according to the commodity being dehydrated.

than can be dried in air. Air-dried strips of more than 3/16 in. thickness require an extremely long time to dry and reconstitution is excessively long and may never be complete. Potato dried by the vacuum contact plate method, on the other hand, tends to form a system of internal cavities which permit of rapid reconstitution. Strips of up to ½ in. x ½ in. have been experimentally produced. These large potato strips, after soaking in water and a short period of boiling, are completely reconstituted and can then be fried in deep fat to give a good approximation to the English potato "chip." The conventional air-dried thinner strip when fried in deep fat merely becomes re-dried and hard.

Fruit have been dried by the vacuum contact plate process with remarkable success. The fruits so far examined include: apples, apricots, bananas, black-currants, damsons, gooseberries, greengages, oranges, peaches, pears, peppers, pineapples, plums, raspberries, strawberries, and tomatoes. In most cases the fruit were dehydrated whole after peeling and, where necessary, stoning, and with the exception of tomato, after steam blanching and sulphiting. Only with some larger fruits were portions used, e.g. segments of orange and rings of apples and pineapples.

During vacuum contact plate drying the temperature of the material being dried can be maintained at a low temperature (15-25° C.) for much of the drying period, rising for vegetables to the finishing temperatures of 60-65° C., for the last 1-2 hours only. (Drying usually takes 4-6 hours). Lower temperatures are used for fruit. This may be contrasted with conditions in air driers, where, at the start, the temperature of the material is the same as the wet bulb temperature of the surrounding air, commonly 45-55° C. and soon rises to dry bulb temperatures, at this stage usually maintained at 60-70° C. The lower temperature conditions of vacuum drying are reflected in a generally better initial color and culinary quality of the vacuum contact plate dried foods over their air dried counterparts, and there is some indication from the results of storage trials now in progress that, other things being equal, vacuum dried vegetables maintained at high temperatures remain acceptable longer.

Although there is little difference in drying time for vegetables between hot air drying and the vacuum contact plate method, the latter method very greatly reduces the long drying times necessary for air drying of fruit. For example, half apricots and peaches can be dried in about 4 hours, and they reach a much lower moisture content; namely, 5-6%.

OTHER PROCESSING CONDITIONS

Scalding. Turning from drying methods to other processing conditions, the water blanching or scalding process which has been the customary process in the United Kingdom has received further critical attention. During serial water scalding the solutes liberated from the vegetable material accumulate in the scalder raising the "soluble solids concentration of the scald liquor." For any particular vegetable passing through the plant at a steady rate of feed, a certain "steady state" of the soluble solids concentration is attained at which the rate of loss of solutes from the vegetable balances the loss of the solutes from the scalder by overflow of the liquor and its entrainment in the scalded vegetable. At low soluble solids concentrations in the scalder the yield of final dried vegetable is naturally lower than when the concentration is high. Recent experiments have given estimates of the magnitudes of such difference in yield. For example, cabbage processed at a scald liquor soluble solids concentration of 1.3% gave a 13% increase in yield of dehydrated material over cabbage scalded at a soluble solids concentration of 0.7%. For carrots an increase in soluble solids concentration from 1% to 4% gave an increase in yield of some 30%.

As a generalization it may be said that vegetables processed at low soluble solids concentrations are weaker in flavor than those processed at high concentrations, but against this defect it is found that such heavily leached material apparently has a longer storage life at high temperatures. With potato, for example, it has been shown that a reduction in strip thickness from 3/16 in. to 3/32 in. not only led to a lower moisture content on drying (4% as against 7%) but resulted in greater

leaching losses which, in itself, considerably increased the resistance of the strips to browning during drying and during high temperature storage. In a comprehensive series of storage tests potato strips of $\frac{3}{32}$ in. x $\frac{5}{16}$ in. cross section with moisture contents ranging from 4-8% have shown their superiority over strips of $\frac{3}{16}$ in. x $\frac{5}{16}$ in. with moisture contents ranging from 6-8%. In storage at 37° C., strips of $\frac{3}{16}$ in. x $\frac{5}{16}$ in. became unacceptable through browning in 4-6 months, while the thinner strips required some 10-12 months to attain a comparable state of browning. These storage tests were complicated somewhat through the material being packed in air instead of nitrogen. The low moisture content thin strips therefore developed off-flavors due almost certainly to oxidative rancidity before the incidence of severe browning. Present tests are with gas-packed material and current commercial production in the United Kingdom is all gas-packed.

Sulphiting. Methods of sulphiting present no great difficulties with vegetables, but some observations on the behavior of sulphur dioxide in dehydrated vegetables may be of interest. It is generally accepted that the higher (within the limits of palatability) the sulphur dioxide content of the dehydrated vegetable the longer will be its storage life under high temperature conditions. It is also known that sulphur dioxide disappears from dehydrated vegetables during storage, the rate of loss increasing with increasing temperature. It has recently been demonstrated that at low moisture contents the sulphur dioxide loss at 37° C. may be almost completely inhibited while free sulphur dioxide in the vegetable increases in the early period of storage and then remains constant at a high level. There is reason for believing that it is this free sulphur dioxide which affords protection against browning.

Compression. During the war the compression of cabbage and carrots into blocks was a standard process in the United Kingdom. Carrots presented little difficulty but cabbage required a tedious process of humidification of the previously dried product and then the pressing of the heated, humified material followed by slow drying of the blocks in a stream of air. It was difficult to the point of impossible to accomplish this slow after-drying without some loss in culinary quality in the product. Blocks of this nature may now be dried by the vacuum contact plate method in 2-3 hours compared with the over-draught air method requiring about 8 hours. Efforts are being made to eliminate the humidification stage in the compression of cabbage and evidence is accumulating that if the cabbage is either steam scalded or scalded in high concentrations of soluble solids it is amenable to a modified compression process. On a small scale, cabbage of 5% moisture content, suitably scalded, has been compressed without the serious fragmentation observed in heavily leached material. There appears to be substantial variation between varieties of cabbage in respect of tolerance of compression. There has been as yet no resumption of the wartime investigations on the compression of dehydrated potatoes.

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Studies on Pickling Spanish-Type Green Olives

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Studies undertaken to prevent or alleviate blister formation, sluggish fermentation, and excessive spoilage of olives produced in Israel by the Spanish method (pretreatment with a dilute lye solution, rinsing, and leaching) are reported. The method has been modified and successfully applied by the olive industry of Israel.

The olive has been cultivated in Israel since the pre-Biblical era. At present about 35,000 acres are covered by olive groves and the crop is converted largely into olive oil. Until 1938 less than 0.2% of the entire crop was utilized as green, pickled olives, but in recent years the industry has developed rapidly—from less than 600 tons of processed fruit in 1948 to about 4000 tons in 1952.

The primitive local curing method, in which the olives are permitted to ferment in salt brine without any pretreatment whatsoever, has been abandoned. It was found to be too slow for commercial purposes. When fermentation was hastened by lightly hitting each fruit, an unsightly product resulted.

The Spanish method of curing has now been introduced and has almost entirely superseded the more primitive systems. With this method the olives are pretreated with a dilute lye solution which, during its penetration into the fruit, hydrolyzes the bitter glucoside-oleorupin *(5, 8, 11, 13)*. After lye treatment the olives are rinsed and leached until all traces of lye are removed. The fruit is then covered with salt brine and permitted to ferment.

Difficulties are encountered with this method; namely, the appearance of blisters shortly after brining, a sluggish rate of fermentation, and excessive spoilage of the olives during storage. Studies undertaken to remedy these shortcomings are described in this paper.

BLISTER FORMATION

Olives which had been lye treated were found to be at times covered with blisters soon after brining, especially in the hottest districts of Israel, i.e. the Jordan valley and the eastern valley of Jezreel. The blisters appear as external protruberances located between the epidermal layer and the pericarp and range in size from a few mm. to as much as 2-3 cm. in diameter. They are elastic, soft and cushion-like when pressed, regaining their shape upon release. If pricked, the blisters collapse. Typical blisters are illustrated in Figure 1.

These blisters affect neither the taste, texture, nor keeping quality of the olives, but such fruit is not marketable. The entire pack, therefore, must be re-sorted and re-packed; this, in addition to the loss of the affected fruit, has caused very serious losses to the industry.

Blisters of similar nature, termed "gas pockets," have been observed in lye-treated California olives before canning *(1, 15, 16, 17, 18)* or during fermentation of the olives *(6, 10)*. These gas pockets are located at varying depths—at times between the flesh and the skin of the fruit, at other times at the depth to which the lye has penetrated. Sometimes they appear in the form of deep fissures extending to the pit of the fruit. Coliform bacteria were found to be associated with these gas pockets *(15, 18)* and their inhibition by better sanitation or by the use of higher acid and salt concentrations has been recommended.

Figure 1. Blisters found on Merhavia olives.

We found blisters forming shortly after brining: 75% of the ultimate number were found to appear within 20 hours and 98% within 46 hours after lye treatment. Their appearance is directly related to temperature, most blisters forming in the hottest pickling sheds, where the temperature of the tap water at times reaches 33° C. or higher. The blisters appear to be due to the dissolving action of the lye upon the connecting tissues underlying the skin, which increases with increasing temperature and lye concentration.

The effect of temperature and concentration of the lye upon blister formation was tested by exposing green olives to varying concentrations of lye. The degree of blistering within four days after brining is recorded in Figure 2.

Blister formation in the Merhavia olive, which is an oblong, medium sized, freestone variety of rather low oil content, is not excessive at the commonly employed concentrations of 1.6 to 1.8% NaOH provided that the temperature does not exceed 27° C. But damage is considerable at 30° C., and may extend to as much as ⅔ of all the fruit if the temperature of the solution approaches 33° C. Blister formation was found to be even higher with the Sevillano variety, as much as 50% of the olives being blistered at 30° C. after a pretreatment with 1.6% NaOH, and over 60% with 1.8% NaOH.

An attempt was made to prevent blister formation by reducing either the concentration or the temperature of the lye solution. Cooling of the lye solution reduced blistering, but increased cost of production. When lower lye concentrations were used, or when the strong base was replaced by a weaker one such as $Ca(OH)_2$, no blisters formed. But the time required for proper penetration was unduly prolonged, penetration did not progress evenly, and the resulting product was therefore not of uniform texture and taste.

Pretreatment of olives with salt solutions was therefore tested. The olives were hardened by immersion in a solution of common salt for several hours before the lye treatment in order to counteract the dissolving action of the lye.

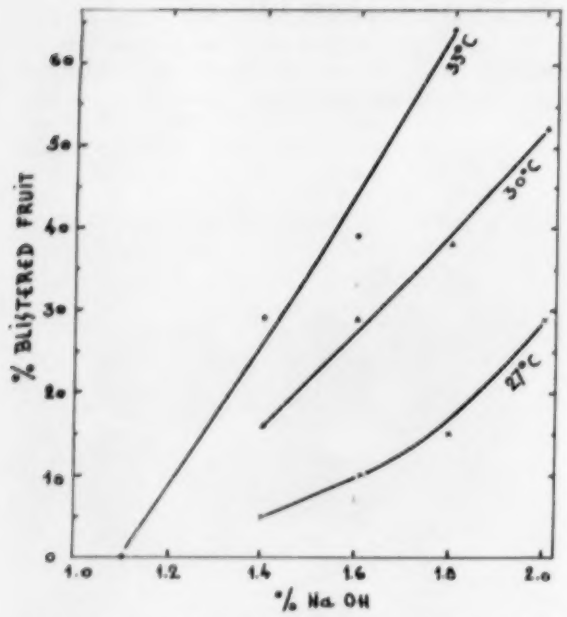

Figure 2. Degree of blister formation in Merhavia olives at varying temperatures and NaOH concentrations.

With concentrations of less than 3% NaCl the degree of blistering was barely reduced, but when concentrations of between 3 to 6% NaCl were used, blister incidence was considerably lowered. Little additional improvement could be obtained above the 6% level, and at higher concentrations some shriveling of the fruit was observed.

Soaking of the olives in salt brine after lye treatment gave similar results. It was thought that the salt treatment might be combined with the lye treatment in one operation. Varying salt concentrations were therefore tested. Typical average results obtained with 1.8% NaOH from a large number of trials for Merhavia and Sevillano olives are plotted in Figure 3.

Results indicate that blister formation is markedly reduced when salt is added to the lye solution so as to produce a final concentration of between 2-3%. The blister-reducing effect of the NaCl treatment is much enhanced in combination with the lye.

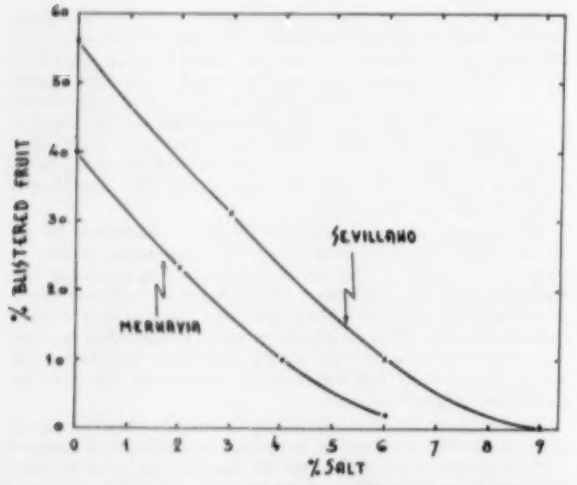

Figure 3. Effect of salt added to lye upon blister formation.

Blister formation decreased with increasing salt concentrations up to about 6% salt. Higher concentrations of salt tended, however, to slow somewhat the rate of lye penetration *(12)*. Penetration time was increased by about 45 minutes at 2% salt concentration, while 6% salt increased it by nearly two hours. Here, too, some shriveling appeared at higher concentrations. Salt concentrations of 3-6% were found to be most suitable.

The addition of salt to the lye has now been generally adopted and has proved satisfactory when used on a commercial scale. No attempt was made to investigate whether, and to what extent, the bacterial flora in the olive brine is affected by this treatment, or whether definite gas-forming microorganisms are the causative factor. It seems unlikely, however, that the addition of such relatively small amounts of salt to the lye, which in itself is strongly bactericidal, would change appreciably the type of microflora in the final brine. It would seem, indeed, more likely that the salt reduced the action of the lye upon cell wall structure so that the skin and the flesh of the olive do not separate. Gas accumulation, due either to microbial activity or to evolution from carbonates, is thereby avoided.

SPOILAGE OF FERMENTED OLIVES

Olives which have been brined and have undergone normal lactic acid fermentation will generally contain enough acid to safeguard the finished product during storage. But at times acidity of the fermented olives remains low—at or below 0.5% lactic acid—in spite of favorable conditions for fermentation, and softening and deterioration during storage will result.

Acid concentration in the fermented product will depend largely upon the amount of fermentable carbohydrates. Since the carbohydrate content of olives is known to decrease during pretreatment *(6, 7, 13)*, the effect of lye treatment, as well as of the subsequent leaching, upon the carbohydrate reserve of the fruit was determined. Cruess *(4)* reports for Spain and California, and Vaughn *(16, 17)* for California, that olives are washed for 20 to 48 hours; in Greece, olives are washed according to Anagnostopoulos *(2)* for 24 to as long as 120 hours, in order to remove all traces of lye.

Analyses carried out during leaching showed that appreciable amounts of carbohydrates are removed during rinsing (Table 1).

TABLE 1

Hydrolyzable sugars in meat of four olive varieties (percent of fresh weight)

Stage	Name of variety			
	Manzanillo	Merhavia	Sevillano	Suri
Fresh fruit	4.7	4.3	5.3	5.2
Immediately after lye treatment	4.5	4.2	5.2	4.8
After 5 hours' leaching	3.0	3.7	4.5	3.6
After 30 hours' leaching	1.8	2.6	3.2	3.1
After fermentation (8 months)	0.8	0.9	0.9	1.1

Less than 5% of the original sugar was lost with the discarded lye; but after 5 hours' leaching, loss reached an average of 40% and, in case of the Manzanillo olives, as much as 60%.

To determine whether prolonged leaching is essential for removal of the lye, alkalinity of the solution was assayed during various stages of leaching. The concentration of NaOH in leaching solutions covering olives which had been treated with 1.8% lye halfway to the pit is recorded in Figure 4.

Figure 4 shows that only little lye accumulates in the leaching solution after the olives had been rinsed 3 times. Since little lye, but much sugar and presumably also other valuable nutrients, are removed during leaching, an attempt was made to remove the excess lye by neutralization rather than by leaching on the assumption that the resulting sodium salt would not affect edibility of the product. Lactic acid, the natural end product of fermentation, was used.

If the neutralizing acid was added together with the brine immediately after lye treatment, fermentation progressed well with high acid production, but the final brine had a light-brown tinge and a slight off-taste.

Addition of the neutralizing acid at various stages of the leaching process was then tested. Best results were obtained

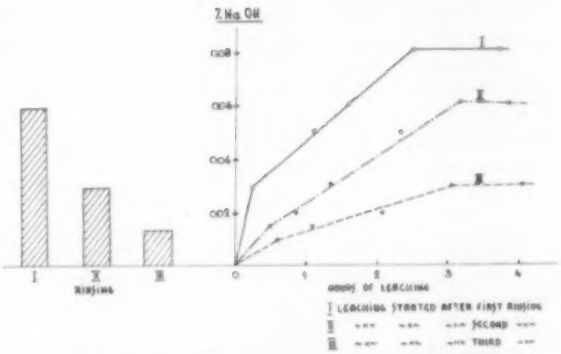

Figure 4. Lye concentrations of leaching solutions during pretreatment of olives.

when the olives were given 3 rinsings immediately after completion of the lye treatment, then soaked in fresh water for about 5 hours, and finally covered with the acidified brine. Since lye concentration after 5 hours of leaching had been found to be much below 0.1% (see Figure 4) low concentrations of acid were employed.

The final acidity as noted in the usual Spanish method was compared with that in the short-leaching, lactic acid-brine system, using two olive varieties pretreated with 1.8% lye halfway to the pit.

Table 2 records the average lactic acid content of these olives after completion of fermentation under uniform conditions. Acid values, rather than pH values of the brine, are recorded since changes in pH value are less pronounced owing to the high buffer value of the fruit.

TABLE 2

Lactic acid content of fermented olives after varying pretreatments

Variety	Pretreatment		% Lactic acid in fermented fruit
	Hours of leaching	% Lactic acid added to brine	
Sevillano	36	0.0	0.41
	5	0.2	1.12
	5	0.3	1.14
	5	0.4	1.20
Merhavia	36	0.0	0.51
	5	0.2	1.31
	5	0.3	1.20
	5	0.4	1.28

Table 2 shows that acidity of the fermented olives remained low after prolonged leaching, lower than required for proper keeping quality, but that it attained 2-3 times higher acidity if leaching was discontinued after 5 hours. The neutralizing acid did not contribute appreciably to the high acidity of the final product, since acid determinations within 24 hours after its addition showed residues of only about 0.05% lactic acid or less.

High levels of acidity are now commonly obtained in pickling sheds wherever this modified, shortened procedure is used. Hence, softening of the fruit during storage has become largely a problem of the past. At times, indeed, acid concentration may be too high for the consumer's taste and the brine must be diluted prior to sale.

This modification of the Spanish method has resulted in additional savings to the industry, since the shortened process economizes in labor and water as well as containers. Additions of supplementary sugars frequently recommended *(3, 6, 8)* can also be dispensed with. Furthermore this modification increases the attractiveness of the final product, giving the olives a much brighter, olive-green color.

SLUGGISH FERMENTATION

In pickling sheds located in the hill regions an additional difficulty was sometimes encountered; acid development in the lye treated olives was slow and inadequate; normal fermentation did not ensue.

Since fruit matures later in the higher altitudes of the hills than in the lowland, this sluggish fermentation was thought at first to be due to the fact that either the fruit had been harvested too early, before sufficient sugars had accumulated, or the lower temperatures in these regions might have prevented optimum development of the lactic acid bacteria.

To test both possibilities, samples of fresh olives from the hill region were fermented in the laboratory under controlled conditions. After lye treatment, one lot of samples was covered with a standard brine and incubated at 27° C.; another lot was set to ferment at room temperature after the addition of glucose to the brine. With both treatments fermentation was somewhat improved, but the rate was still far below normal. Furthermore, glucose tended to cause an undesirable 'gassy' fermentation.

In other tests actively fermenting brine was added but with little effect. If, however, olives of the same origin were allowed to ferment without any previous lye treatment, fermentation was faster and a far higher acidity was obtained.

This suggested that the lye wash water might have leached out in part some of the constituents essential for normal fermentation, but which are present in the fruit only in limited quantities. Lye-treated olives were therefore covered with brine to which various nutrient salts had been added.

Olives from lowland groves which show a normal rate of fermentation were similarly treated. The results are compared in Table 3 with those obtained from the hill regions.

Results in Table 3, which report average results for two seasons, indicate that lye treatment reduced lactic acid development during fermentation in all cases, but that the effect of such treatment was far more pronounced with the hill olives. The addition of 0.15% N in the form of NH_4Cl raised lactic acid content in all lye treated olives, but its effect was far greater in the hill olives, increasing the acid concentration close to that found in the lowland fruit. The acid content increased somewhat with the further addition of 0.15% phosphorus ($NH_4H_2PO_4$) but the presence of such trace elements as Mn, Zn, Cu, Mb, and Fe produced little further rise. If, however, KNO_3 rather than NH_4 salts were used as the nitrogen source, results were somewhat less satisfactory. This would seem to indicate that the cation form of nitrogen is more effective than the anion form.

Data in Figure 5 show that olives from hill regions remain low in acidity even 3 months after brining and are affected but little by the addition of actively fermenting brine. But upon the addition of an ammonium salt, acidity rises rapidly shortly after brining.

TABLE 3

Acid content of olive brine 40 days after onset of fermentation (percent lactic acid)

Additions to brine	Fruit from hill regions				Fruit from lowland regions			
	Lye treated		Untreated		Lye treated		Untreated	
	Room	27° C.	Room	27° C.	Room	27° C.	Room	27° C.
(1) No additions	0.10	0.18	0.26	0.52	0.62	0.75	0.79	0.80
(2) 0.15% N (as NH_4Cl)	0.64	0.66			0.76	0.85		
(3) 0.15% N and 0.15% P	0.74	0.79	0.90	1.19	0.77	0.93	1.04	1.08
(4) The same as (3) with traces of Mn, Zn, Fe, Cu, Mb	0.78	0.80	0.92	1.12	0.89	0.98	0.96	1.09

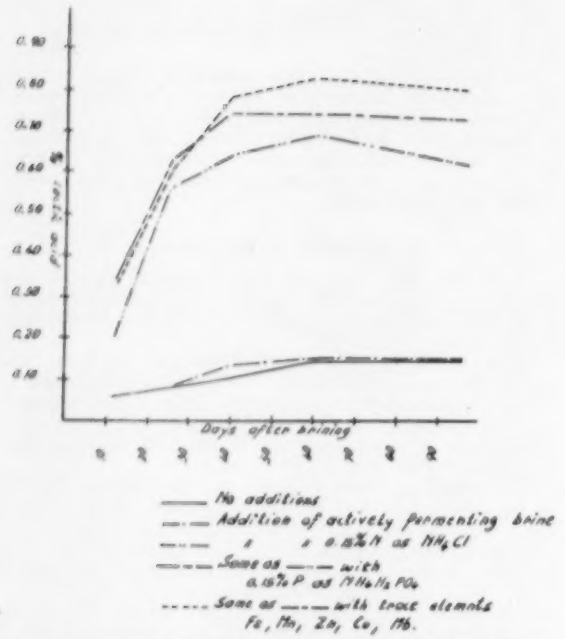
Days after brining
No additions
Addition of actively fermenting brine
Same as with 0.15% P as NH4H2PO4
Same as with trace elements Fe, Mn, Zn, Cu, Mo.

Figure 5. Lactic acid development in olives from hill regions.

In further experiments an appreciable increase in acidity could be obtained upon the addition of as little as 0.05% N, while concentrations above 0.15% N showed little further increase in acidity.

In order to determine whether we were in fact dealing with a nitrogen deficiency, nitrogen was determined repeatedly in both the fruit as well as the leaves of olive trees growing in the shallow soils of the hills and those from the deep, fertile soils of the lowland regions. The percentage of nitrogen in dry matter was found to fluctuate as follows:

	Leaves	Fruit meat
For lowland olives between	1.30-2.00%	0.75-0.91%
For hill olives between	0.72-1.20%	0.35-0.44%

The Division of Horticulture, it should be mentioned, provided fruit samples from trees grown on test plots. Definite yield responses to both nitrogen and potassium fertilizing had been shown. Fruit from fertilized trees showed consistently higher acid accumulation than did fruit from unfertilized control plots. The rate of fermentation in the checkplot was raised if N resp N + K salts were added to the brine, the N + K vats showing faster fermentation than when N only had been added. Thus, it seems, that although nitrogen was the limiting factor in our first experiments, other elements or the ratio between them may at times affect fermentation.

Snell *(14)* states in his review that until recently little attention has been paid to the inorganic requirements of lactic acid bacteria; he assumes that lactic acid bacteria may, similarly to yeasts, be able to synthesize some amino acids from inorganic salts. Various authors *(9, 14)* report the stimulating effect of certain minerals upon the growth of lactic acid bacteria in media which are deficient in them.

The possible effect of the nutritional status of the plant on the activity of the lactic acid bacteria during fermentation of the fruit does not seem to have been extensively investigated. It is evident that field conditions are of direct concern to the food technologist and have a bearing on his efforts to improve products. Further research would appear to be profitable.

SUMMARY

Addition of salt to the lye solution used during preparation of olives prevents the formation of blisters which occur when lye treatment is carried out at high temperatures.

Acid production during fermentation of green olives was much increased when the leaching period was reduced and lactic acid added to neutralize the residual lye; thus excessive loss of fermentable sugars was prevented.

Fermentation of olives from mineral deficient groves, which had been sluggish, was hastened immediately by the addition of nitrogen to the brine.

These methods have proved useful in commercial production and resulted in considerable savings to the industry.

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Further Studies on the Effect of Heat Processing on Tomato Juice Color[a]

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An equation for calculating color loss, derived from a previous study (1), is tested against selected variables comparable to conditions encountered in commercial processing. The equation is shown to be valid under such conditions; namely, differences in heating media, container sizes, and color of raw stock.

Work carried out during the 1952 tomato season showed that the effect of heat application on the color loss of tomato juice proceeded in accordance with the equation: color loss $= \frac{Ts}{525} \frac{(RT-120)}{(40)}$, where color loss is in terms of U. S. grade points, Ts refers to temperature summation in terms of ° F. above 140, multiplied by seconds, and RT is the retort temperature *(1)*.

This work was done with specially devised equipment, and several questions remained unanswered as to the applicability of the equation to commercial processing conditions. Consequently, studies were undertaken during the 1953 season to determine whether this equation remains valid under the following conditions:

A. Use of heating media other than oil baths such as steam retorts.

B. Use of containers of different sizes and shapes.

C. Use of raw stock differing in color quality.

D. Combinations of different heating temperatures.

Effects of heating temperatures and heating times on the validity of the equation were also re-examined.

EXPERIMENTAL

Materials and methods used during the 1953 season were similar to those used during 1952, for determining the effect of combinations of different heating temperatures (Table 5). For the other experiments, where different can sizes and steam heating were involved, Ecklund thermocouples and steam retorts were used in addition to the equipment described previously *(1)*.

Studies on the Effect on Color of Selected Variables

Media and container. The effect of different heating media, container sizes, and times and temperatures of heat application was studied in a factorial experiment consisting of 60 samples for which heating cooling curves were obtained. The color of each sample was obtained before the heat treatment was applied and again after the heat treatment was concluded. Also, the temperature summation was determined from the heating cooling curve, and color loss was determined by the use of the chart in Figure 1. Data in Table 1 represent the difference between the calculated values and the actual color loss obtained for these samples when the U. S. grade equivalent of the processed samples was subtracted from the grade of the raw juice.

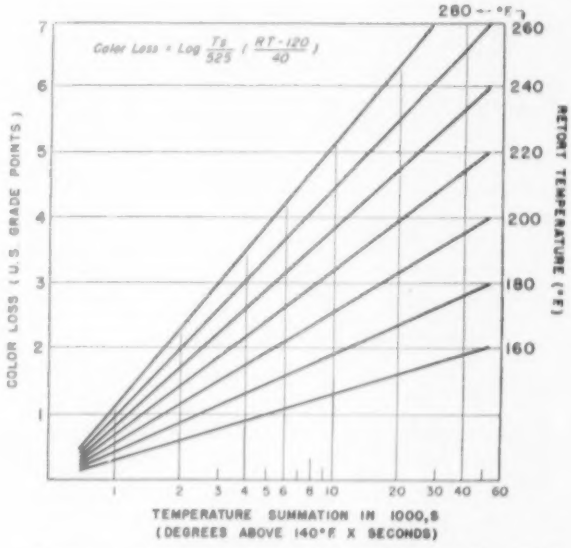

Figure 1. Nomograph for predicting color loss in tomato juice from temperature summations at different retort temperatures.

These results are summarized in Table 2, where it may be noted that in general the calculated results were approximately one-third of one point higher than the results actually obtained. This slight difference may indicate the presence of a slight constant error. The lack of any significant difference among the various treatments may be taken to indicate that the calculated results apply satisfactorily for different heating media, container sizes, and temperatures of heating media. Although the heating time factor was not quite statistically significant, there appeared to be a tendency for those samples which were processed for longer periods of time to have a somewhat higher calculated color loss than that which actually occurred. However, since these long durations of processing are not ordinarily met in commercial practice, it appears safe to state that the equation is valid for all 4 factors of temperature and time in the media, nature of media, and container size.

Raw stock color. Loss of color from tomato juice is obviously a measure of loss of the red color. If raw stock consisting

TABLE 1

Calculated values (+ or −) of color loss of tomato juice during processing as compared to the actual color loss

Can size	Duration of heating [1]	Retort temp. 230° F.		Retort temp. 240° F.	
		Oil bath	Steam retort	Oil bath	Steam retort
4 oz.	1	+0.1	−0.1	+0.1	+0.5
	2	+0.3	+0.1	−0.3	+0.7
	3	+1.2	−0.6	+0.2	+0.5
	4	+0.8	0.0	+0.2	+0.8
	5	+0.6	+0.9	+0.4	+0.2

[1] Duration of heating. Juice removed from heating media when: 1—Temperature of juice reached within 20° F. of the temperature of the media, 2—temperature of juice reached within 10° F. of the temperature of the media, 3—temperature of juice reached the temperature of the media, 4-10 minutes after temperature of juice reached temperature of media, and 5-20 minutes after temperature of juice reached temperature of media.

[a] Scientific Publication No. 2549 Contribution N. A476 of the Maryland Agricultural Expt. Station (Dept. of Horticulture). A report of work done under contract with the U.S.D.A., and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Eastern Utilization Research Branch of the Agricultural Research Service.

TABLE 2

Summary of the effects of various factors on calculated color loss as plus or minus actual color loss in terms of grade points.

Type of Heating Medium:	
Oil bath	+0.343
Steam retort	+0.293
L. S. D.	Not significant
F Value	0.50
Container Size:	
4 ounce can	+0.330
No. 1 picnic can	+0.295
No. 2 can	+0.320
L. S. D.	Not significant
F Value	0.49
Temperature of Heating Medium (RT):	
230° F.	+0.303
240° F.	+0.333
L. S. D.	Not significant
F Value	0.17
Time in heating medium:	
Up to 20° F. below RT	−0.025
Up to 10° F. below RT	+0.210
Up to temperature equal to RT	+0.375
5 minutes longer than time required to reach temperature equal to RT	+0.575
10 minutes longer than time required to reach temperature equal to RT	+0.433
L. S. D.	Not significant
F Value	2.44

of immature green tomatoes or yellow tomatoes were used, very little color loss would occur as a result of heat treatment, since there would be nothing present in the raw stock to be lost. It became of interest, therefore, to establish the point at which this color loss resulting from the application of heat is retarded because of the lack of color in the raw product.

For this purpose, 4 lots of raw tomatoes were selected carefully, with the purpose of providing material that would grade *high fancy, low fancy, standard,* and *substandard* after processing. Half of each of these 4 lots was heat processed so that, by calculation, the processed product would be 2 grade points lower than the original raw juice. The remaining material was heat processed for a longer period of time so that the calculated grade would be 3 grade points lower than the original raw juice. These 8 treatments were replicated 4 times. The results (Table 3) indicate that for the commercial range calculated color losses agree quite well with the actual losses found. As the sub-

TABLE 3

Effect of original raw juice color on color loss of tomato juice during heat processing (Values equivalent to grade score points)

Raw juice	Processed to cause calculated color loss of: 2.0		3.0	
	Score	Loss	Score	Loss
Top Fancy				
32.4	30.2	2.2	29.2	3.2
32.1	30.1	2.0	29.0	3.1
32.0	30.0	2.0	29.0	3.0
32.3	30.1	2.2	29.0	3.3
Low Fancy				
29.3	27.0	2.3	26.0	3.3
28.7	26.9	1.8	26.0	2.7
28.9	27.0	1.9	25.7	3.2
29.0	26.7	2.3	25.7	3.3
Standard				
25.9	24.0	1.9	23.1	2.8
25.8	24.0	1.8	23.4	2.4
25.9	23.8	2.1	23.2	2.7
26.0	24.0	2.0	23.2	2.8
Sub-Standard				
21.8	20.8	1.0	19.7	2.1
21.7	20.7	1.0	20.1	1.6
21.6	20.6	1.0	19.9	1.7
21.8	21.0	0.8	19.9	1.9

standard range of color is approached, however, the calculated color losses became greater than those actually found. These results are summarized in Table 4.

Multiple heating temperatures. It is common practice to preheat tomato juice to temperatures below 210° F. before sterilizing at higher temperatures. In order to simulate such conditions, samples of raw tomato juice were preheated in a 210° F. water bath

TABLE 4

Summary of the effect of raw juice color on calculated color loss as plus or minus actual color loss in terms of grade points

Color of raw juice	Difference of calculated color loss from actual
Top fancy (29)	+0.125
Low fancy (26)	+0.100
Standard (23)	−0.375
Substandard (19)	−1.111
L. S. D.	0.192
F Value	73.30

until juice temperatures reached 180, 190, or 200° F. The heat exchange cell was then placed in a cooling bath until the juice temperature dropped to 105° F., whereupon the cell was placed in an oil bath where the heat was maintained at 245, 255, 265, 275, and 285° F.; the cell was removed from the oil bath when juice temperature reached 240, 250, 260, 270, or 280° F. and cooled. In this way, a total of 45 double heating-cooling curves were obtained. Color was determined on the fresh juice, and again on each sample after heating and cooling in the water and oil baths.

The results (Table 5) show the temperature summations for each sample in the water bath and oil bath separately, together with the calculated color loss values as compared to color loss values obtained by subtracting the actual color values obtained on the heated samples from the color values of the original raw tomato juice. It is obvious from these data that the assumption made previously (A) is correct; namely, that every successive heat treatment is additive in effect and should not be calculated as the beginning of a new computation. This is necessary since color loss is a logarithmic function of temperature summation, and every increment in heating time results in a proportionately smaller increment in color loss.

The method of calculating this color loss resulting from heating at two different temperatures is demonstrated in Figure 2, as follows. For the temperature summation for the preheat treatment of 3.8 (thousand), a color loss of 1.9 grade points is indicated by reference to the figure, since the retort temperature

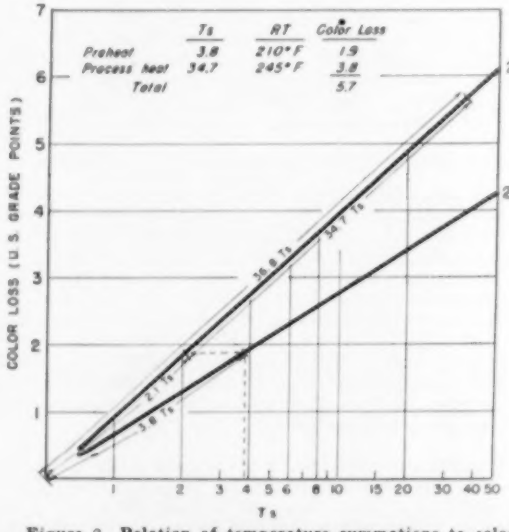

Figure 2. Relation of temperature summations to color loss showing the calculation of color loss when combinations of different retort temperature are employed in processing.

TABLE 5

Effect of preheating tomato juice on final color loss as found and as calculated (all temperatures as °F.)

1	2	3	4	5	6	7	8	9	10
Oil bath temperature	Juice temperature raised to:		T. S. water bath	Calculated [1] color loss	Corrected [2] color loss	T. S. oil bath	Total [3] T. S.	Calculated [4] total color loss	Actual [5] color loss
	In water bath	In oil bath							
245	180	240	3.8	1.9	2.1	34.7	36.8	5.7	5.9
	190	240	4.6	2.2	2.3	36.1	38.4	5.8	6.1
	200	240	10.2	2.9	4.1	34.6	38.7	5.8	6.5
255	180	240	2.9	1.7	1.8	22.5	24.3	5.5	5.4
		250	3.6	1.9	2.0	36.4	38.4	6.2	6.6
	190	240	6.6	2.4	3.0	24.7	27.7	5.7	6.6
		250	5.6	2.2	2.8	37.1	41.3	6.3	7.1
	200	240	9.6	2.9	4.0	23.7	27.7	5.7	6.1
		250	9.8	2.9	4.0	37.3	41.3	6.3	6.4
265	180	240	3.4	1.9	1.8	19.3	21.1	5.7	6.3
		250	3.7	2.0	1.9	26.8	28.7	6.2	6.9
		260	3.8	2.0	1.9	49.6	51.5	7.2	8.0
	190	240	5.0	2.3	2.4	17.8	20.2	5.6	5.2
		250	5.4	2.4	2.5	26.3	28.8	6.2	6.7
		260	7.2	2.6	2.8	74.7	77.5	5.7	8.0
	200	240	9.2	2.9	3.2	18.7	22.1	5.8	5.8
		250	10.5	3.0	3.6	26.4	30.0	6.3	6.3
		260	9.4	2.9	3.4	46.4	49.8	7.1	6.9
275	180	240	3.4	1.9	1.8	19.3	21.1	5.7	6.3
		250	3.8	2.0	1.8	20.0	21.8	6.2	5.5
		260	2.5	1.6	1.4	28.6	30.0	6.7	6.2
		270	4.0	2.0	1.8	46.8	48.6	7.6	6.8
	190	240	5.5	2.3	2.1	17.1	19.2	6.0	5.5
		250	7.2	2.6	2.5	19.4	21.9	6.2	5.6
		260	5.7	2.4	2.2	26.9	29.1	6.7	6.6
		270	6.2	2.5	2.4	42.7	45.1	7.5	7.4
	200	240	10.2	3.0	3.2	15.2	18.4	5.9	5.2
		250	13.7	3.3	3.8	18.2	22.0	6.2	6.2
		260	9.9	2.9	3.0	29.2	32.4	6.9	7.3
		270	11.2	3.0	3.2	45.1	48.3	7.6	7.7
285	180	240	2.7	1.6	1.4	11.1	12.5	5.6	5.1
		250	2.8	1.7	1.4	13.9	15.3	6.0	5.4
		260	3.8	2.0	1.8	18.2	20.0	6.5	5.9
		270	2.3	1.5	1.3	24.9	26.2	7.0	7.1
		280	3.1	1.8	1.5	34.5	36.0	7.7	7.7
	190	240	5.2	2.3	2.0	14.8	16.8	6.1	5.3
		250	5.2	2.3	2.0	17.4	19.5	6.4	6.1
		260	4.8	2.2	1.9	21.1	23.0	6.8	7.2
		270	2.4	1.5	2.0	26.6	28.6	7.2	7.8
		280	4.8	2.2	1.9	51.3	53.2	8.3	8.4
	200	240	12.8	3.2	3.2	13.2	16.4	6.0	4.6
		250	12.1	3.1	3.0	16.3	19.3	6.4	6.1
		260	9.9	2.9	2.7	22.7	25.4	6.9	7.1
		270	8.3	2.8	2.6	30.2	32.8	7.5	7.4
		280	8.8	2.8	2.7	54.1	56.8	8.5	8.2

Legend:

[1] Values in terms of U. S. grade points calculated from nomograph (Figure 2) at 210° F.

[2] Calculated as follows: Calculated color loss at 210° F. in water bath (Column 5) converted to temperature summations at 245° as indicated in Figure 2.

[3] Summation, columns 6 and 7.

[4] Calculated from nomograph (Figure 2) at 245° F.

[5] As determined by Hunter C-D meter.

(RT) for this preheating treatment is 210° F. At the process retort temperature of 245° F., an equivalent color loss of 1.9 grade points would be obtained with only 2.1 (x 10^6) temperature summations (Ts). Hence, this value of 2.1 (x 10^6) Ts is added to the 34.7 (x 10^6) Ts obtained during the process heating at 245° F. for a total of 36.8 (x 10^6) Ts which at an RT of 245° F., would indicate a total color loss of 5.7 grade points.

SUMMARY

Within the limits of good commercial practice, the equation:

$$\text{Color Loss} = \frac{\text{Ts}}{525} \frac{(\text{RT-120})}{(40)}$$

and the nomograph derived from the equation, are valid for calculating color loss in tomato juice under variable conditions of types and temperatures of heating media, container size, and raw stock quality. Where more than one heat treatment is applied, each successive heat application is calculated as an additive effect, rather than the beginning of a new calculation.

LITERATURE CITED

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The Discoloration of Pectin Gels[a,b,c]

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The effects of composition as well as preparation and storage conditions on the darkening and ultraviolet absorption of sugar-acid-pectin gels were studied. Of the variables considered, cooking and storage temperatures, pH and the presence of fructose or ascorbic acid were found to be the major factors affecting discoloration and sugar breakdown. Headspace oxygen did not contribute materially to the darkening nor were significant differences found when several other carboxylic acids were substituted for citric acid at the same pH.

Discoloration of anthocyanin-pigmented fruit preserves and jellies during storage has been shown by various authors to involve two types of color changes: (a) loss of the characteristic color associated with the predominant pigments present and (b) development of a brown color.

In recent years, Kertesz and Sondheimer *(4, 5, 6, 16)*, Mackinney and Chichester *(10)* and Meschter *(12)* have studied the changes in stored strawberry preserves and have established that the reduction of the red color is due to a gradual destruction of the anthocyanin pigments, whereas the formation of browning was associated with the degradation of the sugars. The purpose of the present investigation was to evaluate, in an exploratory manner, the effect of composition and conditions of preparation and storage on the darkening and sugar breakdown in the sugar-acid-pectin fraction of fruit preserves. To preclude interference by other fruit constituents normally present in a preserve, model systems, prepared from the components under study, were used.

EXPERIMENTAL

The following variables were selected to determine their effect on the color stability of pectin gels: (a) cooking time and temperature, (b) storage time and temperature, (c) nature of sugar, (d) concentration and nature of carboxylic acid, (e) presence of ascorbic acid, and (f) nature of headspace gas.

A "standard jelly" was used in the experiments on processing, storage, and headspace variables, whereas a "standard cook" was applied to samples in the experiments on composition variables.

The effects of the above treatments were measured by spectrophotometric determination of changes at characteristic wave lengths in the visible and in the ultraviolet range.

Preparation of the "standard jelly." The formula for the preparation of the synthetic jelly used in all the experiments except those designed to determine the effect of composition was:

63.75 g. of sugar (commercial sucrose)
0.75 g. of pectin (100 grade slow set citrus pectin)[d]
0.50 g. of citric acid (A.C.S. grade)[e]
35.00 g. of distilled water

100.00 g.

The pectin was intimately mixed with the dry sugar, and the distilled water added. The mixture was then heated to a temperature of 180° F. until dissolved, care being taken to prevent evaporation. The acid was added only after the other constituents were fully dissolved. Ten-milliliter portions of the hot jelly were poured into 18 x 150 mm. lipless Pyrex test tubes, which were then sealed in an oxygen flame.

Adjusting headspace gas composition. When headspace gas was to be other than air, the filled test tubes were drawn to a capillary by means of an oxygen torch, and placed in a desiccator fitted with a three-way stopcock. The chamber was evacuated by a vacuum pump, the vacuum being released with either oxygen or nitrogen gas. The operation was repeated at least four times to insure replacement of the original air headspace by the oxygen or the nitrogen. The tubes were then removed from the desiccator and immediately sealed in an oxygen flame.

Heating jellies. All jellies were heated prior to storage to effect sterilization and simulate the cooking conditions of commercial open-kettle preparation. The sealed tubes were heated in an oil bath equipped with a deKhotinsky thermo-regulator. At the end of the heating period, the tubes were rapidly cooled in an ice water bath.

Except when the heating time itself was the variable, tubes of jelly were subjected to a standard cook of 30 minutes at 230° F. As illustrated in Figure 1, this cook is somewhat more severe than that applied during a typical preparation of strawberry jam in this laboratory using an open, steam-jacketed kettle. This cook was nevertheless selected because the optical density of the resulting gel was found to fall on linear portions of both the temperature (for 30 minutes) and time (at 230° F.) vs. optical density graphs.

Measurement of discoloration. As an index of jelly darkness, the optical density of the samples was determined at 450 mμ, by means of a Model 14 Coleman Spectrophotometer.[f] Test tubes containing the samples were placed directly in the instrument; the reference standard was a test tube filled with distilled water. Although more accurate results would undoubtedly have been obtained by diluting the jelly samples and measuring their optical density in conventional cuvettes, the exploratory nature of these experiments did not require greater accuracy than that actually obtained by the shorter method used.

Measurement of sugar degradation products. The changes in the ultraviolet absorption spectra, which accompany the thermal breakdown of sugar solutions, have been the subject of contributions by numerous workers in the field. A critical review of the newer literature encompassing the whole field of browning reactions in model systems was recently published by Hodge *(3)*.

[a] Presented at the Fourteenth Annual Meeting of the IFT at Los Angeles, June 29, 1954.

[b] Contribution No. 952, Massachusetts Agricultural Experiment Station.

[c] This paper reports research undertaken in cooperation with the Quartermaster Food and Container Institute for the Armed Forces, and has been assigned number 489 in the series of papers approved for publication. The views or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or indorsement of the Department of Defense.

[d] Obtained from California Fruit Growers Exchange, Ontario, Calif.

[e] Obtained from Eimer and Amend, New York 14, N. Y.

[f] Manufactured by Coleman Instruments, Inc., 318 Madison St., Maywood, Ill.

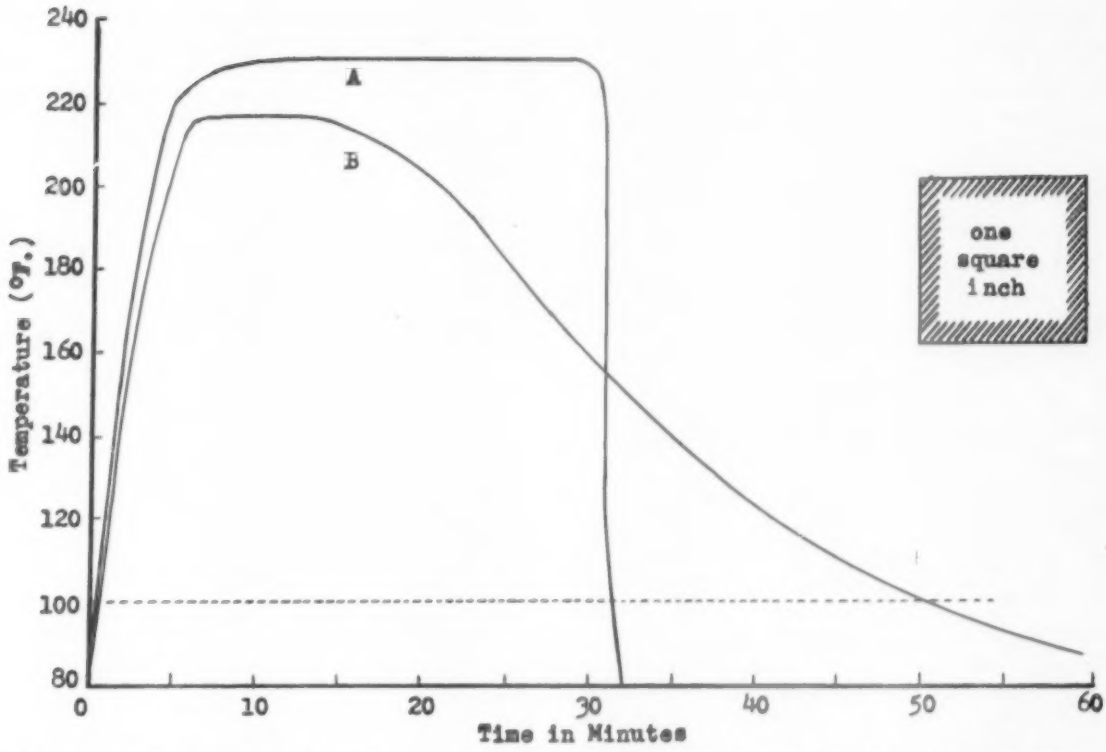

Figure 1. Heating-cooling curves of A. 10 ml. pectin gel in 18 x 150 mm. Pyrex test tube heated in oil bath and cooled in ice water, and B. strawberry jam cooked in steam-jacketed open kettle and cooled in 6-oz. jelly glasses immersed in cold water. Area under Curve A: 9.21 square inches; area under Curve B: 8.20 square inches.

Part of the review was devoted to a discussion of browning in the presence of nonamino organic acids, which had been reported by various authors including Lewis, Esselen and Fellers *(7)*, Patron *(14)* and Livingston *(8)*. Browning is presumed to be a result of the chemical degradation of sugars and the polymerization of some of the resulting breakdown products. Changes in the ultraviolet spectra of such model systems are related to the formation of furfural derivatives, including 5-hydroxymethyl-2-furaldehyde, (HMF), according to various workers cited by Hodge *(3)*. In the present study, the presence of HMF was confirmed in heated jelly by chromatographic means. Descending paper chromatography was carried out at room temperature using n-butanol, ethyl alcohol and water (45:5:50) as the solvent *(1)*. The paper used was Whatman No. 4, and the detecting spray was an aniline-acetic acid solution, which reacts with HMF to form a red-colored spot. The compound was identified by comparison with a known spot of pure HMF (prepared by the method of Haworth and Jones, *2*) which was cochromatographed with the unknown. Light absorption maxima in the area of 282.5-285 mμ in the ultraviolet range are generally accepted as evidence of the presence of HMF, although solutions of furfural and certain other furfural derivatives are also known to exhibit interfering characteristic spectral absorption maxima in nearby bands. However, analytical methods for the determination of furfural and HMF, by means of their ultraviolet absorption, have been used by Smith and Rogers *(15)* and Livingston, Esselen and Fellers *(9)*, respectively. In the present study, since the extent of sugar degradation incurred as a result of the various treatments is of greater interest than the actual amounts of HMF produced, the optical density of the samples in the ultraviolet range could be used as a measure of sugar breakdown. Unfortunately, the degree of dilution required to permit spectrophotometric measurement varies with the concentration of HMF present, so that optical density values are meaningful only in the light of the dilution factor.

To present the ultraviolet absorption data in a more readily intelligible manner, the HMF content of the samples was calculated according to the method described by Livingston, Esselen and Fellers *(9)*. Although errors are unquestionably inherent in this method because of the presence of the interfering substances in the samples (Mackinney and Temmer, *11*) and in the purified HMF used as reference (Miller and Cantor, *13*) it is felt that the absorption data are more useful when expressed in terms of HMF concentration than as optical density. It is, in a sense, similar to the practice of expressing the total acidity of a food product in terms of the predominant acid present.

Prior to measurement of optical density at 285 mμ with a Beckman Model DU Spectrophotometer,[8] samples of jelly were gently warmed until liquefied to permit pipetting into volumetric flasks for appropriate dilution.

RESULTS AND DISCUSSION

Effect of heating times and temperatures. The effect of 5 heating temperatures (ranging from 212° F. to 250° F.) on changes in optical density and HMF content of gels is indicated in Tables 1 and 2; visual darkening ratings are also listed. Although ultraviolet absorption and, consequently, HMF increased rapidly as the cooking temperature was raised, the effect on gel color did not become very obvious until the temperature exceeded 230° F. At 220° F. the optical density at 450 mμ over the 40-minute heating period increased as a linear function of the heating time. At 230° F. the linearity was retained only over the first 30 minutes of heating.

[8] Manufactured by Beckman Instrument, Inc., South Pasadena, Calif.

At both temperatures, however, the rate of HMF production increased rapidly after 20 minutes. Therefore, it appeared from these observations that the formation of HMF precedes the development of browning—which is in accordance with the known role of HMF as a precursor of browning in systems of this type.

The ultraviolet absorption of "unheated" gels is undoubtedly due to the fact that some sugar degradation does occur in the course of the mild preliminary heat treatment required for the preparation of the gel mixture.

TABLE 1
Effect of heat treatment and storage on the darkening of standard jelly

Heating		Optical density at 450 mμ					Visual darkening rating after heating
		0 days	Stored at 25° C.		Stored at 37° C.		
Time (min.)	Temp. (° F.)		15 days	30 days	15 days	30 days	
0	....	0.245	0.248	0.250	0.252	0.253	None
10	212	0.265	0.270	0.275	0.280	0.282	None
10	220	0.283	0.290	0.295	0.300	0.310	Trace
10	230	0.310	0.315	0.340	0.360	0.375	Trace
10	240	0.360	0.375	0.380	0.390	0.400	Slight
10	250	0.510	0.530	0.540	0.610	0.640	Marked
10	220	0.255	.....	0.265	.....	0.267	None
20	220	0.265	.....	0.270	.....	0.275	None
40	220	0.290	.....	0.330	.....	0.350	Trace
10	230	0.265	.....	0.280	.....	0.287	None
20	230	0.282	.....	0.310	.....	0.287	None
40	230	0.360	.....	0.380	.....	0.392	Slight

TABLE 2
Effect of heat treatment and storage on ultraviolet absorption in standard jelly

Heating		Ultraviolet absorption (at 285 mμ)					
		Optical density (0 days)	as HMF (mg./100 ml.)				
			0 days	Stored at 25° C.		Stored at 37° C.	
Time (min.)	Temp. (° F.)			15 days	30 days	15 days	30 days
0	....	0.140[1]	9.8	10.5	11.4	12.2	14.6
10	212	0.110[2]	36	39	43	45	47
10	220	0.137[2]	47	59	65	73	74
10	230	0.205[2]	74	89	97	107	116
10	240	0.280[2]	105	116	121	126	132
10	250	0.480[2]	183	195	199	207	215
10	220	0.268[2]	19.5	.....	26	.....	29
20	220	0.350[2]	26	.....	31	.....	37
40	220	0.168[2]	61	.....	81	.....	93
10	230	0.113[2]	38	.....	45	.....	57
20	230	0.136[2]	47	.....	73	.....	80
40	230	0.270[2]	102	.....	121	.....	129

[1] 1:200 dilution.
[2] 1:500 dilution.
[3] 1:100 dilution.

Effect of storage times and temperatures. To determine the effects of storage on the darkening and ultraviolet absorption of pectin gels, tubes of the standard jelly were stored at approximately 77° F. (25° C.) and 98° F. (37° C.) for up to 30 days. The results of such storage on discoloration are also indicated in Table 1. In all cases, storage increased the extent of discoloration as functions of both time and temperature. Formation of HMF was similarly affected by storage conditions (Table 2).

Effect of headspace gas composition. Tubes of standard jelly heated and stored under pure oxygen and nitrogen gas were also examined for darkening and ultraviolet absorption. The data are summarized in Tables 3 and 4. The presence of oxygen appears to be slightly favorable to darkening and HMF production during heating, though not in storage.

TABLE 3
Effect of headspace gas on the darkening of standard jelly[1] during heating and storage

Headspace gas	Heating temp. (° F.)	Optical density at 450 mμ				
		0 days	Stored at 25° C.		Stored at 37° C.	
			15 days	30 days	15 days	30 days
O_2	230	0.325	0.330	0.350	0.370	0.385
Air	230	0.310	0.315	0.340	0.360	0.375
N_2	230	0.308	0.310	0.340	0.360	0.370
O_2	240	0.365	0.380	0.385	0.400	0.410
Air	240	0.360	0.375	0.380	0.390	0.400
N_2	240	0.340	0.355	0.365	0.375	0.396

[1] Heated for 30 minutes.

TABLE 4
Effect of headspace gas on ultraviolet absorption in standard jelly during heating and storage[1]

Headspace gas	Heating temp. (° F.)	Ultraviolet absorption (at 285 mμ)				
		Optical density (0 days)[2]	as HMF (mg./100 ml.)			
			0 days	Stored at 25° C.		Stored at 37° C.
				15 days	30 days	15 days	30 days
O_2	230	0.215	77	93	105	113	125
Air	230	0.205	74	89	97	108	116
N_2	230	0.203	73	89	100	108	116
O_2	240	0.290	109	119	125	129	132
Air	240	0.282	106	116	121	126	132
N_2	240	0.265	97	105	109	125	128

[1] Heated for 30 minutes.
[2] 1:500 dilution.

Effect of composition. To determine the relative importance in darkening of some of the constituents of pectin gels, the basic formula of the "standard jelly" was sufficiently altered, as indicated, to allow the effect of individual sugars and acids to be considered. Unless otherwise stated in Tables 5-9, which summarize the resulting data, the composition of the standard jelly

TABLE 5
Effect of sugars on heated and stored jelly

Sugar	Storage		Optical density		Ultraviolet absorption as HMF (mg./100 ml.)
	Time (days)	Temp. (° C.)	450 mμ	285 mμ[1]	
Fructose	0	25	0.520	0.385	146
Fructose	15	25	0.540	0.413	157
Fructose	30	25	0.580	0.438	167
Fructose	15	37	0.600	0.460	175
Fructose	30	37	0.640	0.510	196
Sucrose	0	25	0.310	0.205	74
Sucrose	15	25	0.315	0.242	89
Sucrose	30	25	0.340	0.265	97
Sucrose	15	37	0.360	0.285	105
Sucrose	30	37	0.375	0.310	116
Glucose	0	25	0.240	0.400[2]	3.0
Glucose	15	25	0.242	0.415[2]	3.2
Glucose	30	25	0.245	0.450[2]	3.4
Glucose	15	37	0.250	0.464[2]	3.5
Glucose	30	37	0.260	0.510[2]	3.9

[1] 1:500 dilution.
[2] 1:10 dilution.

was adhered to as closely as possible, both qualitatively and quantitatively.

In all instances, the previously defined "standard cook" was applied.

Sugars. According to Table 5, when fructose and glucose were substituted for the sucrose in preparing the jelly, significant differences in the rates of darkening and HMF production were encountered. The presence of fructose contributed significantly to both darkening and HMF formation, whereas in the presence of glucose, a clear, light gel, low in HMF content, resulted. Sucrose retained an intermediate position in its activity, presumably because of its inversion into equal amounts of glucose and fructose. In all cases, the effects of storage time and temperature were similar to those observed with the standard jelly.

TABLE 6
Effect of citric acid concentration on heated and stored jelly

Citric acid (%)	Storage		Optical density		Ultraviolet absorption as HMF (mg./100 ml.)
	Time (days)	Temp. (° C.)	450 mμ	285 mμ[1]	
0.5	0	25	0.310	0.205	74
0.5	15	25	0.315	0.242	89
0.5	30	25	0.340	0.265	97
0.5	15	37	0.360	0.285	106
0.5	30	37	0.375	0.310	117
1.0	0	25	0.320	0.360	138
1.0	15	25	0.365	0.410	154
1.0	30	25	0.400	0.450	171
1.0	15	37	0.410	0.470	179
1.0	30	37	0.440	0.500	193
1.5	0	25	0.430	0.490	187
1.5	15	25	0.470	0.540	207
1.5	30	25	0.520	0.618	238
1.5	15	37	0.490	0.580	224
1.5	30	37	0.570	0.665	256

[1] 1:500 dilution.

Acids. The effect of acidity on the jelly was determined by preparing jellies with citric acid contents of 0.5, 1.0 and 1.5%, but otherwise similar to the "standard jelly." Darkening as well as HMF production was found to be promoted at the higher levels of acidity during both heating and storage.

TABLE 7
Effect of carboxylic acids on heated and stored jelly

Acid (0.5%)	Storage		Optical density		Ultraviolet absorption as HMF (mg./100 ml.)
	Time (days)	Temp. (° C.)	450 mμ	285 mμ[1]	
Citric	0	25	0.310	0.205	74
Citric	15	25	0.315	0.242	89
Citric	30	25	0.340	0.265	97
Citric	15	37	0.360	0.285	106
Citric	30	37	0.375	0.310	116
Tartaric	0	25	0.308	0.202	73
Tartaric	15	25	0.315	0.242	89
Tartaric	30	25	0.340	0.267	100
Tartaric	15	37	0.358	0.280	105
Tartaric	30	37	0.370	0.306	115
Malic	0	25	0.300	0.180	65
Malic	15	25	0.307	0.194	71
Malic	30	25	0.312	0.225	81
Malic	15	37	0.314	0.236	85
Malic	30	37	0.355	0.278	105
Succinic	0	25	0.250	0.080	30
Succinic	15	25	0.252	0.090	34
Succinic	30	25	0.285	0.140	49
Succinic	15	37	0.260	0.102	37
Succinic	30	37	0.288	0.160	57
Succinic[2]	0	25	0.290	0.170	61
Succinic[2]	15	25	0.306	0.191	69
Succinic[2]	30	25	0.312	0.220	81
Succinic[2]	15	37	0.312	0.222	81
Succinic[2]	30	37	0.350	0.270	101

[1] 1:500 dilution.
[2] pH 3.0.

In the light of recent data by Livingston *(8)* on the relative darkening rates of several sugar-acid systems, it was deemed desirable to investigate the effect of various carboxylic acids, and primarily malic acid, on the jellies. Consequently, jellies were prepared with 0.5% tartaric, malic, and succinic acids being substituted for the citric acid in the standard jelly. In another series of experiments, the effect of malic acid in the presence of fructose and glucose as well as sucrose was determined. As seen in Table 7, little difference in darkening or HMF formation resulted from the substitution of citric acid by either tartaric or malic acids in the presence of sucrose. The substitution of succinic acid, however, caused a marked reduction in discoloration and HMF production. Subsequent pH measurement on freshly prepared gels showed that in the presence of 0.5% citric, malic, or tartaric acid, a pH of approximately 3.0 resulted, whereas a value of 3.4 was found with succinic acid. An additional experiment was, therefore, carried out using a succinic acid-containing jelly whose pH was adjusted to pH 3.0 by means of the addition of dilute HCl. Results of observations on this jelly indicate that at this lower pH level approximately the same degrees of darkening and HMF formation were evidenced as with the other acids.

TABLE 8
Effect of malic acid and sugars on heated and stored jelly

Sugar	Storage		Optical density		Ultraviolet absorption as HMF (mg./100 ml.)
	Time (days)	Temp. (° C.)	450 mμ	285 mμ[1]	
Fructose	0	25	0.450	0.345	130
Fructose	15	25	0.480	0.360	136
Fructose	30	25	0.530	0.395	150
Fructose	15	37	0.540	0.412	156
Fructose	30	37	0.610	0.464	175
Sucrose	0	25	0.300	0.180	65
Sucrose	15	25	0.307	0.194	72
Sucrose	30	25	0.312	0.225	82
Sucrose	15	37	0.314	0.236	85
Sucrose	30	37	0.355	0.278	105
Glucose	0	25	0.235	0.380[2]	2.8
Glucose	15	25	0.240	0.410[2]	3.1
Glucose	30	25	0.244	0.440[2]	3.3
Glucose	15	37	0.248	0.460[2]	3.5
Glucose	30	37	0.255	0.500[2]	3.8

[1] 1:500 dilution.
[2] 1:10 dilution.

TABLE 9
Effect of ascorbic acid on jelly during heating

Ascorbic acid (%)	Optical density		Ultraviolet absorption as HMF (mg./100 ml.)
	450 mμ	285 mμ[1]	
0	0.310	0.205	74
0.01	0.330	0.215	77
0.10	0.360	0.262	97

[1] 1:500 dilution.

When malic acid was substituted for citric acid in the presence of fructose, sucrose and glucose, no major differences after heating or storage were observed, although both optical density at 450 mμ and HMF content were

slightly lower for the jellies containing the malic acid (Table 8).

Ascorbic Acid. Since ascorbic acid occurs naturally in many fruits from which preserves are made, it was desired to establish its effect on the changes in pectin gels during heating. Using the standard jelly as a basis, ascorbic acid was added at 0.01% and 0.10% levels. The addition of ascorbic acid, particularly at the higher level, was found to result in higher optical densities at both the visible and ultraviolet wave lengths used for measurement (Table 9).

SUMMARY AND CONCLUSIONS

Effects of time and temperature of heating and storage, headspace oxygen, type of sugar, nature and concentration of acid, and the presence of ascorbic acid on the darkening and ultraviolet absorption of sugar-acid-pectin gels were determined.

Changes in the ultraviolet absorption spectra, attributed to the formation of 5-hydroxymethyl-2-furaldehyde (HMF) and related sugar degradation products, were found to precede the onset of visual discoloration. Both HMF production and darkening occurred as functions of time or temperature of exposure to heat, either in cooking or in storage. Under conditions only slightly more rigorous than are likely to be found in the course of preserve-making by the open-kettle method, significant darkening and sugar breakdown resulted. The changes continued to follow this course, though at a reduced rate, at ordinary storage temperatures of 25° C. (77° F.).

The exclusion of headspace oxygen from tubes containing the jellies did not prevent, nor indeed materially reduce, either darkening or HMF production. Therefore, oxygen is not presumed to be involved in the thermal degradative processes responsible for these changes.

The darkening and HMF production were considerably increased when fructose was the sole sugar. Conversely, there was no visual discoloration and very little change in the ultraviolet absorption when glucose was used alone. The presence of sucrose resulted in changes numerically intermediate to those obtained with the other sugars.

The addition of ascorbic acid resulted in increased darkening and ultraviolet absorption of the jelly during heating.

At the increased acidity levels, both discoloration and HMF formation were accelerated, though only minor differences attributable to specific carboxylic acids could be found when the original pH values of the systems were kept at 3.0.

Acknowledgments

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Application of the Thiobarbituric Acid Test to Cereal and Baked Products

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A modification of the thiobarbituric acid test for oxidation products of unsaturated fatty acids is suggested, in which the red compound is separated from yellow interfering substances by adsorption on cellulose, followed by elution with aqueous pyridine. Application of the method to certain cereal and baked products is described.

The thiobarbituric acid test, based on a reaction described by Kohn and Liversedge *(4)*, has been shown by Bernheim, Bernheim, and Wilbur *(1)* to measure oxidation products of unsaturated fatty acids. It depends upon the colorimetric estimation of a red compound produced when the acidified sample is heated in the presence of 2-thiobarbituric acid (TBA). The test was applied to milk by Dunkley and Jennings *(3)*, whose procedure has been investigated and modified for application to other dairy products by Biggs and Bryant *(2)*. A recent publication by Turner et al. *(6)* describes application of the test to frozen pork.

The principal difficulty encountered in testing materials other than pure fats is the formation of yellow interfering compounds. The red color is associated with intensity of oxidized flavor *(3)* but the yellow color has been attributed to the presence of sugars in the digest *(2)*. In order to apply the test to extracts of cereal and baked products, a chromatographic procedure for separation of the yellow components has been devised, allowing the residual red color to be estimated in an ordinary colorimeter or spectrophotometer. The test method to be described has been adapted from that of Patton and Kurtz *(5)* with insertion of the chromatographic step. It would appear to provide a more sensitive and reproducible means of detecting and recording incipient oxidative rancidity than the peroxide value technique.

MATERIALS AND METHODS

Reagents. TBA reagent was prepared as directed by Kohn and Liversedge *(4)*, a satisfactory solution being obtained without charcoal adsorption. Eluent mixture was prepared by diluting 100 ml. fresh reagent quality pyridine to 500 ml. with distilled water.

Adsorption columns. These were prepared by plugging the tips of 7 x 120 mm. glass columns with glass wool, and filling the column to a packed height of 50 mm. above the plug with cellulose powder (Whatman standard grade). The powder was packed by tapping the columns sharply several times on a clean solid surface. The columns were placed in a rack in which provision was made for applying air pressure in order to accelerate the adsorption and elution process.

Modified TBA test. The material to be tested is ground and 20-g. samples extracted overnight with petroleum ether in a Soxhlet apparatus equipped with 300-ml. round bottom flasks. Most of the solvent is then removed by distilling into the extraction chamber, and the remainder evaporated by heating the flasks for a few minutes on a steam bath.

To each flask when cool is added 7.5 ml. distilled water, 6.0 ml. TBA reagent and 3.0 ml. 20% trichloroacetic acid, together with a glass bead to control bumping. The flasks are fitted to condensers and the contents gently refluxed for exactly 10 minutes from the incidence of boiling, following which they are removed and chilled in ice-water. Ten-ml. quantities of the aqueous layers are transferred by pipette to centrifuge tubes and 3 ml. chloroform added. The tubes are stoppered, shaken vigorously, and centrifuged to remove turbidity from the aqueous layer.

Aliquots of 7.0 ml. are then transferred to the adsorption columns and forced through with 5 p.s.i. air pressure. Each column is washed successively with three 1-ml. portions of distilled water, air pressure being used to clear the columns between washes. This treatment has been found to carry the yellow fraction through the columns without developing the adsorbed red fraction to the point where loss occurs. A 10-ml. volumetric cylinder is then placed under each column, and the adsorbed red fraction eluted with aqueous pyridine, exactly 10 ml. being collected. Optical density is read at 532 mμ against a reagent blank obtained by carrying an extra flask through all parts of the procedure but omitting the unknown sample. A Coleman Universal spectrophotometer with 19 × 105 mm. cuvettes was found to be satisfactory.

Products tested. Data are presented on application of the method to 3 types of baked products—oat cereals, oatmeal cookies, and soda crackers. The cereals were prepared in the laboratory on pilot scale equipment. The oatmeal cookies were baked in the laboratory using a standard domestic formula with lard as the shortening agent. The soda crackers were commercial products, their formula being unknown. All were subjected to accelerated storage at 38° C., samples being removed weekly or bi-weekly for analysis by the method outlined. At the same time, the coded samples were evaluated organoleptically by an independent and experienced observer.

RESULTS

Stability of oat cereals. Two types of dry oat cereal were tested. Results for 4 different lots of each are given in Table 1. The samplings at which rancidity could be detected organoleptically are indicated.

TABLE 1

Stability of oat cereals at 38° C.

Time, weeks	Optical densities at 532 mμ							
	Cereal A				Cereal B			
	1	2	3	4	1	2	3	4
0	0.03	0.06	0.05	0.03	0.04	0.04	0.02	0.03
1	0.04	0.15	0.08	0.04	0.03	0.05	0.03	0.05
2	0.05	0.19	0.05	0.05	0.03	0.06	0.05	0.04
3	0.09	0.29[1]	0.08	0.11	0.03	0.05	0.04	0.07
4	0.11		0.08	0.11	0.03	0.05	0.07	0.08
5	0.11		0.15	0.15	0.03	0.07	0.07	0.06
6	0.15		0.13	0.14	0.05	0.10	0.06	0.09
8	0.21		0.09	0.21	0.07	0.10	0.09	0.10
10	0.23		0.09	0.23	0.07	0.10	0.10	0.13
12	0.39[1]		0.09	0.39[1]	0.08	0.11	0.12	0.14
14			0.13		0.07	0.15	0.16	0.16
16			0.13		0.09	0.14	0.17	0.18
18			0.27		0.11	0.17	0.15	0.17
20			0.29[1]		0.15	0.16	0.15	0.22

[1] Rancid.

Stability of oatmeal cookies. Two batches of cookies were prepared from the same formula. The lard used in one contained no added antioxidant, while that used in the other had been stabilized with a mixture of propyl gallate, citric acid, and butylated hydroxyanisole. Results are given in Table 2. Samples of the lards were also kept at 38° C. and 4-ml. samples analyzed directly by the TBA procedure at the beginning and end of the experiment. This sample size corresponded approximately with the amount of extract obtainable from 20-g. cookie samples. Initial results for unstabilized and stabilized lards were 0.52 and 0.19 respectively, while final results were 1.15 and 0.32.

TABLE 2
Stability of oatmeal cookies at 38° C.

Time, weeks	Optical densities at 532 mμ	
	Unstabilized	Stabilized
0	0.19	0.10
1	0.25	0.08
2	0.34	0.09
3	0.26	0.11
4	0.42	0.07
5	0.38	0.07
6	0.55[1]	0.07
8	0.90[1]	0.09
10	1.10[1]	0.16

[1] Rancid.

Stability of soda crackers. In one experiment, crackers obtained fresh in 4-ounce cellophane packages were kept at 38° C. One package was removed from storage and tested each week, with the results given in Table 3. Organoleptic rancidity was not detected during the period studied, but there was a gradual rise in optical density.

In another experiment rancid crackers of various ages were analyzed simultaneously along with several fresh samples of the same manufacture, with the results given in Table 4.

TABLE 3
Stability of soda crackers at 38° C.

Time, weeks	Optical density 532 mμ
0	0.04
1	0.06
2	0.10
3	0.06
4	0.07
5	0.12
6	0.08
8	0.10
10	0.17
12	0.12
14	0.21
16	0.21
18	0.23

DISCUSSION

The modified TBA test as described in this paper would appear to provide a numerical index of oxidative rancidity in oat cereals and other dry baked products despite the presence of other chromogenic substances. In most cases, the trend of results during the early weeks of storage is indicative of the potential stability of the product. The attainment of certain optical density levels seems to be correlated with the onset of rancidity; for instance, samples of oat cereal A almost invariably smell rancid when an optical density over 0.25 is reached.

TABLE 4
Comparison of fresh and rancid crackers

Age, weeks	Condition	Optical density 532 mμ
1	fresh	0.03
14	rancid	0.69
17	rancid	0.96
21	rancid	1.00
23	rancid	1.04
25	rancid	0.90
28	rancid	1.00

The method is presented here as a research tool, suitable for following on a routine basis the progress of fatty acid oxidation in samples undergoing normal or accelerated storage tests. As with other indices of rancidity, the numerical range corresponding to the actual onset of rancidity varies between products. This might be minimized by varying the initial sample weight so as to keep the amount of extract constant. Application of the method to a variety of products as a control procedure would undoubtedly require some such further standardization.

Acknowledgments

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Plate Type Heat Exchanger as a Source of Bacterial Contamination in Processing Frozen Concentrated Orange Juice[a]

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(Manuscript received December 17, 1954)

Many processing problems have accompanied the advent and rapid growth of the frozen citrus concentrate industry. Of major importance to bacteriologists are (a) maintenance of an efficient sanitation program to insure a minimum total count of microorganisms in the product and (b) production of concentrate free from abnormal flavors and odors, one of which is described as being similar to those characterizing buttermilk *(2, 3, 4, 6)*.

In recent years, there has been a trend toward controlled heat treatment of the product during manufacture, not only to inactivate most of the pectic enzymes present in the concentrate in order to improve physical stability during storage *(1, 7, 8)*, but also to reduce bacterial contamination. Several designs of heat exchangers are available; those most commonly used in Florida by the citrus industry are of either the plate type or direct steam injection type. *Stabilizing*, the term employed to designate the use of heat to treat the juice, is usually accomplished by *flash heating* the product, either as it enters the evaporators, or early in the process of concentration. Temperatures ranging from 150° F. (66° C.) to 190° F. (88° C.) are not uncommon, with holding times of 2-15 seconds, followed by rapid cooling within the exchanger, or by flashing the juice to the evaporators. Under normal operating conditions, this type of heat treatment results in an 80-99% reduction in bacterial population *(5)*. In the operation studied, where a plate heat exchanger is employed, it was observed that, from time to time, instead of a reduction in bacterial population *(5)*. In the operation studied, crease resulted. These periods of high counts occurred spasmodically, usually just prior to shutting the plant down for a cleanup. Normally, the juice was heated to 150° F. (66° C.) for 2.5 seconds and cooled to 110-120° F. (43-49° C.) in the regenerative section of the unit. During the periods of bacterial buildup, it was noted that the predominant colonies on line check plates after the heat exchanger were of the pinpoint type. It was suspected that the regenerative section of the stabilizer was the source of trouble; therefore, an investigation was made to study this phase of the problem.

PROCEDURE

A plate-type heat exchanger similar to the one illustrated in Figure 1 was investigated as a source of contamination. This unit, for the purpose of illustration, has been partially opened to show its construction. Sampling taps were installed on the juice line at the point where the juice entered the stabilizer, between the heating and regenerative sections, and at the outlet end of the unit. Juice was collected from each tap in sterile screw cap test tubes after the taps were thoroughly flushed with the product. Samples from the heating section were cooled immediately by immersing the tubes in cold water. All samples were plated immediately on orange serum agar and the plates counted after 48-72 hours of incubation at 86° F. (30° C.). The product was sampled in this manner twice per day over a period of one month. Representative colonies were picked from those plates from the regenerative section which showed by visual inspection a noticeable increase in numbers over plates made from unheated juice. The organisms isolated were considered significant if growth occurred in 12° Brix orange juice at 120° F. (49° C.). All the isolates were microaerophilic, catalase-negative rods, which produced pinpoint colonies on orange serum agar and, therefore, were assumed to belong to the same genera. For this reason, only the growth and temperature characteristics of one isolate (strain No. R7) was studied in orange juice of various concentrations.

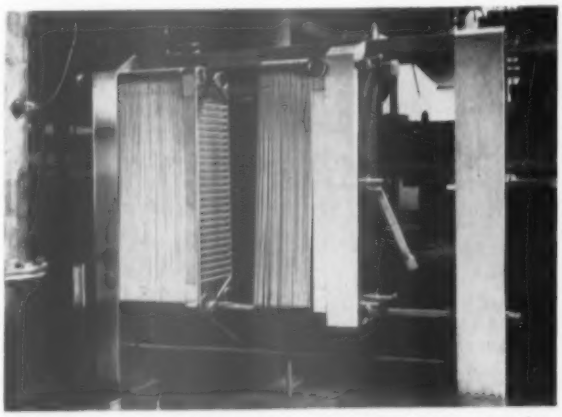

Figure 1. Plate-type heat exchanger showing plate construction.

The effect of temperature and concentration on the growth of the test organism was ascertained in 12°, 20° and 30° Brix orange concentrate. These levels of concentrate were obtained by adjusting 42° Brix concentrate pH 3.8, with water. The concentrate in bottles with glass beads was sterilized by flowing steam, cooled, and inoculated with a known quantity of an actively growing 24-hour culture of the test organism. This organism was kept active by making daily transfers at 120° F. (49° C.) into sterile 20° Brix orange juice of pH 3.8. Each sample of a given degree Brix was incubated at 78°, 110°, 120° and 130° F. (26°, 43°, 49° and 54° C.) and plated in duplicate from the same bottle on orange serum agar every 2 hours for the first 8 hours and at longer intervals up to 24 hours as indicated in the data. The plates were counted after 48 to 72 hours of incubation at 98° F. (37° C.).

RESULTS

The plate-type heat exchanger consists of a series of stainless steel plates designed to give the maximum amount of heat transfer. The flow of product through a unit of this type is quite complex, as indicated in Figure 2. In some installations,

[a] Presented at the Sixty-seventh Meeting of the Florida State Horticultural Society, Miami Beach, Florida, October 20, 1954.

only the heating section is used, while in others, a combination of heating and regeneration is employed in order to achieve more economic utilization of heat. The latter arrangement was used in these studies to stabilize the orange juice. In this installation, the juice was flash heated early in the process of concentration to 150° F. (66° C.) for 2.5 seconds and cooled, as previously stated, to 110°-120° F. (43°-49° C.) in the regenerative section of the unit.

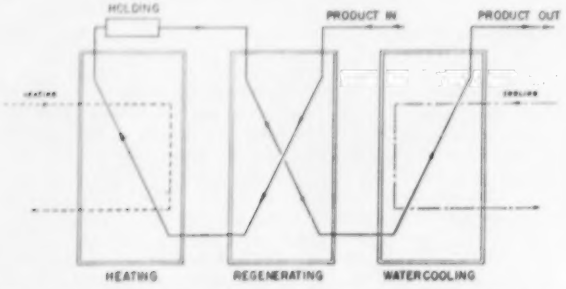

Figure 2. Typical flow diagram of plate type heat exchanger.

An example of some of the data, showing a bacterial buildup in a plate-type heat exchanger, is presented in Table 1. The focal point of contamination was found to be in the regenerative section, as the data in Table 2 indicate. It was observed during periods of bacterial buildup, that the microflora of stabilized juice differed from those of unheated juice. This is evidenced

TABLE 1
Number of microorganisms per milliliter of conceatrate before and after heat exchanger

Holding time 2.5 sec. at 150° F.

Test no.	Before entering heat exchanger	After leaving heat exchanger
1	7,000	200
2	25,000	1,100
3	27,000	147,000
4	7,000	205,000

TABLE 2
Number of microorganisms per milliliter of concentrate before and after heating section, and after regenerative section

Holding time 2.5 sec. at 150° F.

Test no.	Before entering heat exchanger	Immediately after heating section	After regenerative section
1	30,000	<10	200
2	117,000	<10	400
3	135,000	<10	30,000
4	135,000	<10	2,000
5	133,000	300	23,000
6	133,000	1,000	32,000
7	131,000	4,000	123,000

by the colony formation noted on orange serum agar line check plates made before and after stabilizing (Figure 3). The colonies before heat treatment were predominantly gum formers, and those after stabilizing were principally pinpoint colonies.

A test organism (strain R7), which was thought to be representative of the contamination found in the heat exchanger, was isolated and identified by J. M. Berry, Research Department, Continental Can Company, as a heterofermentative *Lactobacillus*. This organism was found capable of growing over a wide temperature range; i.e., a minimum of 50°-60° F. (10°-16° C.) and a maximum of 110°-121° F. (43°-49° C.). It closely resembles the species description of *L. buchneri*, with the exception that its optimum temperature range for growth is several degrees higher than that of *L. buchneri*.

The test organism was grown in orange juice of 12°, 20° and 30° Brix at 78°, 110°, 120° and 130° F. (26°, 43°, 49° and 54° C.) in order to simulate conditions found in the stabilizer. It was found that there was little or no difference in the growth of the test organism in orange juice of 12° and 20° Brix at the temperatures investigated. This also was true for the various sugar concentrations at temperatures of 110° F. (43° C.) and 120° F. (49° C.). For this reason, only the data shown in Figure 4 are presented, which are the average results of 3 test runs. It appears from the data that the optimum conditions for growth of the organism in orange juice are in the range of 12° to 20° Brix and at temperatures between 110° (43° C.) and 120° F. (49° C.). The greatest microbial activity occurred at this temperature range during the first 6 hours of growth. The organisms increased during this period from 160,000 microorganisms per ml. to over 2,000,000 microorganisms per ml. and continued to

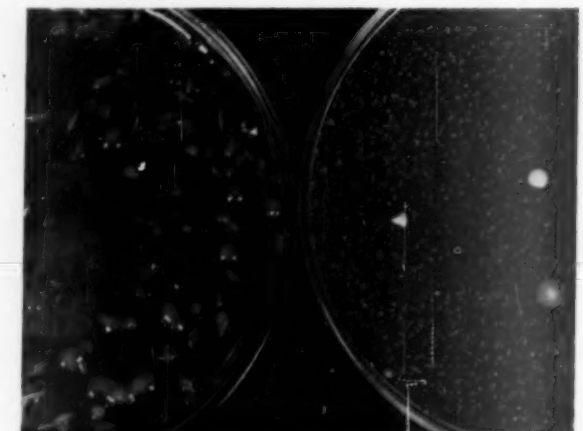

Figure 3. Orange serum agar plates after 48 hours of incubation at 86° F., left to right, before and after heat treating orange concentrate.

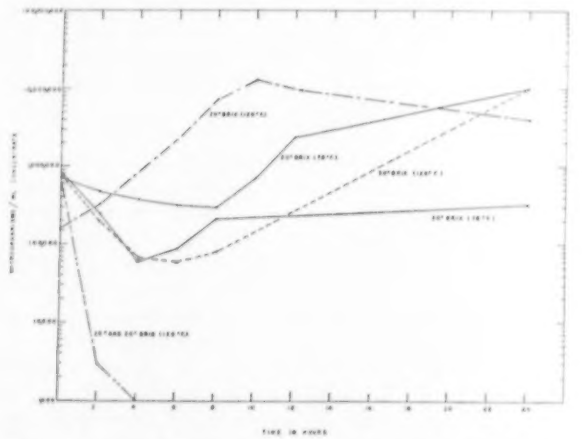

Figure 4. Growth curves of test organism in orange concentrate.

grow at a constant rate up to 10 hours. Growth was considerably slower at 78° F. (26° C.) than at 120° F. (49° C.). For example, in orange juice of 20° Brix approximately 24 hours were required for a tenfold increase, while only 6 hours were needed at 120° F. (49° C.). In 30° Brix juice, the test organism grew at a slower rate at both temperatures. It grew faster, however, at 120° F. (49° C.) than it did at 78° F. (26° C.). No growth occurred in any of the orange juice samples held at 130° F. (54° C.). At this temperature, the organisms survived for 2 hours and were reduced to less than 10 per ml. in 4 hours.

It is conceivable that regenerative (or cooling) sections of a plate-type heat exchanger of the type investigated could be a potential source of contamination of orange juice in the Brix range of 12° to 20° if it became heavily seeded with an organism whose growth and temperature characteristics were similar to those of strain R7. It is interesting to note that orange juice (12° and 20° Brix) tested at the end of 6 hours of incubation at 110° F. (43° C.) and 120° F. (49° C.) gave a positive Voges-Proskauer (V.P.) reaction, indicating the presence of acetyl-methyl-carbinol and/or diacetyl, compounds commonly associated with "buttermilk" off-flavor *(4, 6)*. Organoleptic examination of the juice also indicated the presence of this flavor.

CONTROL

Control can be accomplished in a number of ways, some of which, without regard to flavor or other considerations, are:

Eliminate any regenerative or cooling section of the heat exchanger operating in the critical temperature range (approx. 100°-120° F.) (38° C.-49° C.), and flash the juice directly into the next stage of evaporation.

Clean the stabilizer thoroughly every 4 to 6 hours. If possible, use two heat exchangers in parallel, cleaning one while the other is in operation.

Cool the juice after heating to a temperature above the growth range of the organism; i.e., 130° F. (54° C.).

Stabilize the juice at a high enough temperature to obtain 100% destruction of all bacterial cells present in the juice.

Stabilize juice above 30° Brix.

SUMMARY

Data have been presented to show that the regenerative section of a plate-type heat exchanger can be a potential source of bacterial contamination. A test strain was isolated from a typical plate-type exchanger as being representative of the causative organism. It was identified and found to resemble closely *Lactobacillus buchneri*. The growth of the test organism in orange juice of 12°, 20° and 30° Brix was determined at temperatures of 78°, 110°, 120° and 130° F. (26°, 43°, 49° and 54° C.). Optimum conditions for growth of the organism in orange juice were in the range of 12° and 20° Brix at temperatures between 110° (43° C.) and 120° F. (49° C.). At 78° F. it grew at a much slower rate, and at 130° F. (54° C.) no growth occurred. Suggestions for controlling bacterial contamination in a plate-type heat exchanger are presented.

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Rapid Moisture Determination in Frozen Lima Beans[a]

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(Manuscript received September 13, 1954)

Use of the Launer-Tomimatsu method of determination of moisture by dichromate oxidation and electrometric titration with ferrous ammonium sulfate is reported for frozen lima beans. With reference to the determination by the vacuum oven method, the oxidation method gives statistically reliable results. The "F" value (dichromate factor) for lima beans is computed for several varietal types. Although there is little variation in the dichromate factor among varieties, a statistically significant correlation of this factor with maturity, as measured by moisture content, is evident.

A previous study, part of which was reported by Sterling and Boggs *(6)*, showed that physiological maturity of lima beans, as indicated by alcohol-insoluble solids content, is adequately measured by moisture content. Considerable additional evidence in the literature *(1, 2, 3, 7)* supports this fact. As one of the advantages of objective measures of maturity is ease of reproducibility, attention was directed to finding a method of moisture determination that would be accurate and precise and yet fairly rapid. The theoretical basis of the Launer-Tomimatsu method *(4, 8)* apparently confers such advantages. This method is based on the oxidation of a well-macerated sample with potassium dichromate solution in the presence of concentrated sulfuric acid. Following oxidation, which is at least 99% consummated in 4 minutes *(8)*, the excess dichromate is titrated with a ferrous ammonium sulfate solution to an electrometric end-point. From the titration data can be calculated a so-called "dichromate factor" *(F)*, which represents grams of dry material oxidized per ml. of standard dichromate solution for a given type of material. Obviously the *F* value for any commodity will vary according to its composition *(4)*.

This paper reports the results of the application of the Launer-Tomimatsu method to the measurement of moisture in samples of frozen lima beans. It is concerned with the variation of the value of the dichromate factor with varietal differences and maturity differences in beans.

MATERIALS AND METHODS

There were 246 commercial samples of frozen lima beans represented in the present study. These were provided by the Agricultural Marketing Service of the U. S. Department of Agriculture and originated in the following states: California, Idaho, Maryland, Minnesota, New Jersey, and Washington. They included 79 samples of the Fordhook type (Concentrated Fordhook, U. S. 242, and unnamed varieties), 3 of the baby potato type (Evergreen), and 164 of the Baby Lima or thin-seeded type (Wilbur, All green, Henderson, Thorogreen, PH 106, Green Seeded, and unnamed varieties). There were no data on cultural conditions or on the methods of processing of any of these samples.

Sample preparation. After a package of beans was removed from freezing storage (—20° F.), the beans were placed in a porcelain pan and thawed overnight in a household-type refrigerator. Upon thawing, the beans were wrapped in cheesecloth towelling and rolled gently to remove excess moisture from their surfaces.

A sample of 100.00 g. of beans was weighed out and placed in an Osterizer jar. Then 300.00 g. of distilled water at room temperature were added in two steps: (a) blending with about 200 g. of water for 4 minutes; and (b) washing down the sides of the jar with the remaining water and blending for an additional minute.

Oven moisture. While the above slurry was being stirred with a magnetic stirrer, 25 ml. of slurry were removed with a pipette to a tared aluminum moisture dish. Both dish and slurry were weighed to the nearest 0.001 g. Preliminary drying was carried out overnight on a steam bath, following which the dish and its contents were placed in a vacuum oven at 70° C. and 29.5 in. of Hg vacuum for 48 hours. The dish was cooled in a desiccator and weighed to the nearest 0.001 g.

Total solids percentage of the bean slurry was calculated on the basis of the proportionate weight of sample in the diluted slurry. Percentage of moisture was given by: 100 — percentage total solids.

"Dichromate" moisture. The method of Launer and Tomimatsu *(4)* was followed exactly. While the same slurry, from which the sample for oven moisture was taken, was being stirred, 2 ml. of slurry were removed with a pipette and placed in a tared 400 ml. Pyrex beaker. Beaker and slurry were weighed to the nearest 0.001 g. According to the details of the oxidation method, 25.00 ml. of 1.835 N standard potassium dichromate solution were added to the stirring solution, followed by gradual increments of concentrated H_2SO_4. After 4 minutes the solution was diluted with 150 ml. of distilled water. Electrodes were placed in the solution and connected with a potentiometer and 6-volt battery. Titration of the unreduced dichromate with ferrous ammonium sulfate solution was carried out to an electrometric end point, and the volume used to titrate was determined to the nearest 0.01 ml. Calculation of the *F* value (dichromate factor) is based on the moisture content as given by the oven moisture determination, the *D* value (ml. of dichromate reduced), and the dilution factor. This essentially follows the formula: Percentage moisture = $100\ (1 - F \times D)$.

After the *F* value was computed for each sample, an average *F* was determined for all the samples of a varietal (or species) type: Fordhook, baby potato, baby lima. This average value was then used with the *D* value for each sample to give a "calculated" moisture content. The difference between the oven moisture and the calculated moisture is the "error." Average errors were computed for each of the varietal types. Also, the differences between the mean *F* values for each varietal type were analyzed for statistical significance by the "t" test *(5)*. In addition, coefficients of regression (r) between oven moisture (as representing degree of bean maturity) and the *F* values were calculated for each varietal type and for the whole group of samples.

RESULTS AND DISCUSSION

The range in maturities, as judged by bean appearance and the percentage moisture content was considerable. In the Fordhook type, the highest moisture value was 74.4% and the lowest 55.8%. The baby lima bean

[a] A report of work accomplished in part under a contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Fruit and Vegetable Division, Agricultural Marketing Service.

extremes were 74.3% and 24.6%, respectively. The three samples in the baby potato type ranged from a high value of 69.6% to a low value of 63.0%.

In Table 1 the average F values are shown. The average error between oven and calculated moisture, which has been computed without regard to algebraic sign, is also given in this table. The value of this average error

TABLE 1
Dichromate factor F and moisture results for various samples of frozen lima beans

Varietal type	Average dichromate factor (F) and standard deviation	Average error between oven moisture and calculated moisture (%)
Fordhook	0.01419 ± 0.00032	0.68
Baby lima	0.01392 ± 0.00041	0.74
Baby potato	0.01373 ± 0.00014	0.33
All	0.01400 ± 0.00038	0.72

is considerably less than the error due to sampling alone. Duplicate measurements on 41 other sample packages gave an average sampling error in oven moisture content of 2.02%, which is nearly three times as large as the largest average error between oven moisture and calculated moisture.

These values indicate, therefore, that on a statistical basis the dichromate moisture method is reliable in terms of accurate reflection of oven moisture content.

When the dichromate factor is compared with the moisture content via the regression coefficient (Table 2),

TABLE 2
Coefficient of regression r between F values and oven moisture content

Varietal type	r	F_r [1]	$F_{0.05}$ [1]	$F_{0.01}$ [1]
Fordhook	−0.245	4.92	3.96	6.97
Baby lima	−0.515	58.89	3.91	6.80
Baby potato	−0.921	5.58	161.00	4052.00
All	−0.674	206.36	3.89	6.76

[1] "F" here is variance ratio.

it can be seen that there is a statistical relationship between these two values. For the baby lima type and the group as a whole, the coefficient is highly significant, statistically. The Fordhook beans show a relatively low correlation, which is still statistically significant, *i.e.*, the F_r value is greater than the $F_{0.05}$ value, indicating that the coefficient is unlikely to have been this high by chance alone. Because of the very few samples (three) of baby potato limas, the high coefficient falls short of statistical significance. It will be noted that the sign of the coefficient is negative, indicating that as the moisture content declines with increasing maturity, the dichromate factor increases. It is interesting to note that the reverse trend seems to hold true for the 18 samples of peas examined by Launer and Tomimatsu *(4)*.

The differences between the mean F values of the three main varietal types were analyzed for significance according to the "t" test. If the number of degrees of freedom is based on the smaller number of the two bean populations compared, the difference between the mean F values of the baby lima and the baby potato types is not statistically significant; that between the baby potato and the Fordhook type is barely significant (at the 5% level of probability); and that between the baby lima and Fordhook types is highly significant (less than 1% probability that the "t" value is due to chance alone). Nevertheless, it is noteworthy that there is little actual difference among the mean values of these varietal types: all fall within 2% of the value of the overall mean F.

SUMMARY

The rapid dichromate moisture method was applied to lima bean samples representing different varieties and varietal types, different maturities, and different regions of growth. The overall average error in calculating the moisture content from an average dichromate factor was 0.72%. This was distributed among the varietal types as follows: Fordhook type, 0.68%; baby lima type, 0.74%; and baby potato type, 0.33%. A statistically significant negative coefficient of regression obtained between the dichromate factor F and maturity, as indicated by the moisture content. Relatively small differences existed among the average F values for the different varietal types.

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Determination of Gas in Glass Packed Food Products[a]

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(Manuscript received October 15, 1954)

A rapid method for the determination of the gas content of glass packed foods of the mayonnaise type is described.

It is well known that most foods, whether natural or processed, contain a certain amount of incorporated gases, such as oxygen, nitrogen and carbon dioxide. The nature and amount of gas incorporated in a food product plays an important role in flavor, texture, and keeping quality. Numerous investigators have reported that the presence of oxygen in food products causes destruction of vitamins, enzyme actions, rancidification of fats, browning reactions, destruction of desirable colors, etc. Whether or not the presence of the gas is desirable in a particular food product, it is necessary to know its level for proper control in food processing.

Numerous methods for the determination of gases in food products appear in the literature. Most of these, it seems, are devised for a specific food product, and many are cumbersome and time-consuming. For example, Gray and Stone *(3)* describe a precise method for the determination of CO_2 and air in packaged beer and carbonated beverages. This method consists of puncturing the cap of the container and shaking the gas into the alkali absorption bulb. Coffey and Spannuth *(2)* determine air in shortening by correlating the specific gravity of alcohol water mixture with that of the shortening. Loeffler *(5)* studied the deaeration of orange juice before pasteurization and worked out a method for air and CO_2 determination based on the principle of evacuation of the gases from a known volume of the juice and measurement of the gases in a micro-burette.

Joffe's *(4)* method which is specifically designed for the mayonnaise type of products includes the breaking of the mayonnaise emulsion in a sealed jar and sweeping the air evolved with a current of CO_2. The air is then collected in a burette and its volume is measured. Schaffer and Haller *(8)*, in their study of the solubility of gases in butter oil, cottonseed oil, and lard, determined gas content by evacuation of the oils at various temperatures and measurement of the gas in a burette. Dissolved gases in peanut butter were studied by Vincent and Szabo *(9)*. Their vacuum extraction technique consists essentially of heating a weighed sample of peanut butter in a brine solution to disperse it, and then evacuating the mixture and measuring the air.

In 1949 Loeffler's gasometric method was modified by Bayes, Flook and Graham *(1)*. This technique involves the evacuation of a sample at higher temperatures and volumetric determination of the gases evolved. It has been used in our laboratories to some extent, but the method has its limitations in that it is not readily adaptable to semi-solid and solid food products. Quite recently, H. R. MacDonnell *(6)* published a method based on the principle of the displacement of the product during its expansion under vacuum. The air in butter may be determined by the method of Mohr and Eysank *(7)*. The butter is immersed in a bath of glycerol and heated to break the emulsion; the escaping air is collected in an inverted funnel, filled with glycerol, and held over the bath.

There are also numerous standards and suggested methods for the determination of gases in products other than food products, such as mortars, paints, cosmetic cream, etc. Some of these methods may be adapted to foods and are worthy of investigation.

METHOD AND PROCEDURES

The method described here is used in our laboratories for semi-solid emulsions such as mayonnaise and salad dressing. It is based on the principle of the displacement of occluded gas by a suitable liquid such as saturated brine or alcohol. The product to be tested is immersed in the liquid and dispersed by agitation. The gas is transferred to a burette by displacement and its volume is measured. If desired, the gas may be analyzed by the regular Orsat apparatus.

Figure 1 shows the sketch of the apparatus with a sample of mayonnaise for air determination. It is made from an ordinary

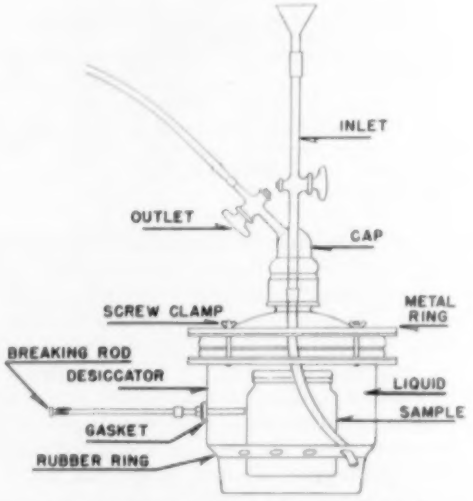

Figure 1. General design of apparatus used.

vacuum desiccator. A hole is drilled on the side and a movable metal "breaking rod" is set in and secured by means of an air tight gasket. A suitable holder is set in the desiccator to hold the jar tightly in place. The cover is clamped by means of adjustable metal rings with rubber gaskets. The cover is equipped with a 2-way tight-fitting cap, one tube to serve as inlet for the liquid and the other as outlet for the gas.

The gas is determined as follows:

Mayonnaise is taken as an example. The unopened jar containing the mayonnaise is fitted into the holder in the desiccator (Figure 2). The desiccator is covered and the cover clamped

[a] Presented at the Fourteenth Annual Meeting of the IFT, Los Angeles, California, June 29, 1954.

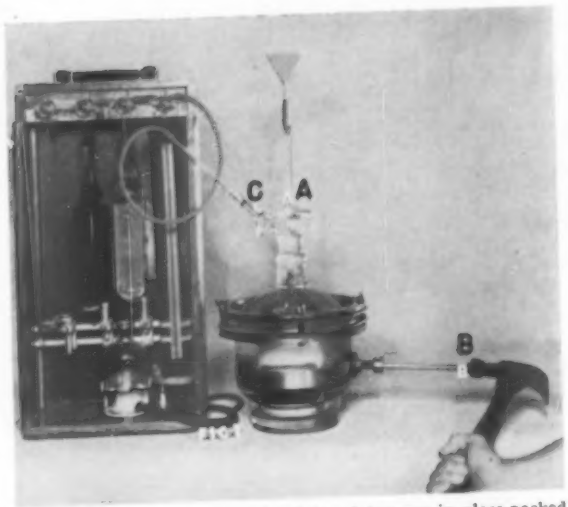

Figure 2. Showing set-up for determining gas in glass-packed product.

tightly by means of the screw clamps as shown. Stopcocks A and C are opened and the desiccator as well as the tube leading to the gas burette are filled with alcohol from the funnel above. Care should be taken to avoid entrapping of the air under the jar bottom or under the curl of the jar cap. This is avoided by tilting or mildly shaking the desiccator while it is being filled. The stopcocks are then closed, the funnel removed, and the jar is broken by striking the metal "breaking-rod" with a hammer at B. The desiccator is then shaken; the broken glass jar serves as an aid in breaking the emulsion and dispersing the product tested. The emulsion breaks, and the ingredients disperse throughout the body of the liquid. The gas rises to the top of the glass cap. The funnel is attached, filled with alcohol, stopcocks C and A are opened, and the gas is forced into the burette of the gas analyzer, as shown.

RESULTS AND DISCUSSION

The table of data is given for the air content of several mayonnaises prepared in the laboratory, production samples, and one or two competitive products, as well as salad dressings (Table 1). It is interesting to note that there can be as much as 100% variation in the air content in mayonnaises of the same formula but different in their mode of processing, as shown by the samples coded 210-11 with 210-12 and 324-1 with 324-3. In the case of the two samples of salad dressings, vacuum packed dressing 610-5 has a higher air content than the sample 604-11 which was packed under atmospheric pressure. By this, it is not meant to infer that vacuum packed salad dressings contain more air, these data are shown to point out the effect of the method of processing on the air content of the product packed.

Therefore, quality control tests on a food product should include the determination of its gas content. Although no data are included for air content of other food products, tests have been made successfully with this apparatus. This method possesses the following distinct advantages:

(a) Increased accuracy because a large volume of the sample is used for analysis.

(b) It is rapid; a determination can be made in less than 10 minutes.

(c) It can be used to determine gas content of vacuum-packed food products. Many food products are packed under vacuum and it is frequently desirable to know the efficiency of the vacuum pack. For example, what is the relative air content of a jar of mayonnaise which is packed under vacuum as compared to atmospheric packing? To our knowledge, there is no other method by which gas content of vacuum packed mayonnaise may be determined. Using this method, the jar is unsealed, and its total air content may be accurately measured.

The method has been used primarily for semi-solid food emulsions of the mayonnaise type, but it can also be used for other types of foods such as mustard, ketchup, sandwich spreads, etc., whether they are vacuum-packed or packed under atmospheric conditions.

TABLE 1
Air content
Mayonnaise

Code	Ml. Air/Pint	% Air (vol.)
YO8-2	25.7 ml.	5.7%
YO8-4	20.4	4.5
YO8-5	16.6	3.7
YO8-6	18.4	4.0
210-11 } Same formula but different processes	{ 40.2, 38.7	{ 8.8
210-12 }	{ 18.4, 18.3	{ 4.1
74	29.4, 29.6	6.5
76	23.5, 24.2	5.3
Comp.	21.4, 21.6	4.8
210-13	34.6, 35.4	7.7
324-1 } Same formula but different processes	{ 22.6, 23.8	{ 5.1
324-3 }	{ 16.3, 16.2	{ 3.6
Salad Dressing		
610-5 Vacuum packed	47.2	10.4
604-11 Regular pack	31.6	7.0

SUMMARY

Literature on the existing methods of the determination of gases in food products is reviewed. A method is described for the determination of gases in food products of the mayonnaise type. Its applicability to the determination of gases in vacuum-packed food products is illustrated.

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Discoloration of Fresh Red Meat and Its Relationship to Film Oxygen Permeability[a]

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Several causes of discoloration of fresh red meats are discussed. Emphasis is laid on the role of oxygen availability. Oxygen permeability requirements of films suitable for packaging fresh red meats are determined.

In the past few years there has been a tremendous increase in the volume of meats sold through self-service outlets. The American housewife has become accustomed to selecting her steaks and other cuts of meat from carefully arranged refrigerated display cabinets. These meats are packaged in transparent flexible packaging materials designed to maintain the attractive appearance of the meat as long as possible.

Probably the most important single factor in the sales appeal of packaged meats, particularly beef, is color. Beef with a bright red surface will certainly attract the customer; beef with extensive brown discoloration will probably be rejected.

Discoloration of fresh meats is a function of several factors, of which oxygen availability is the most important. In this paper the rôle of these factors in self-service meats will be discussed. Finally, an effort will be made to point out the limitations imposed by bacterial and enzymatic action on the display life of fresh meats stored under ideal conditions.

The color of meat is caused by the presence of certain respiratory pigments, the myoglobins, which are very closely related to hemoglobins in the blood. Hemoglobin serves to transport oxygen from the lungs to the tissues, where it is released to myoglobin. As shown by Hill *(8)*, this latter pigment has an even greater affinity for oxygen, particularly at the low oxygen pressures found in muscle tissue. This pigment transports oxygen to the oxidase-cytochrome system in the cells. Myoglobin is a heme protein with a molecular weight of about 17,500 (compared to 68,000 for hemoglobin), and has only one iron porphyrin unit per molecule. Hill showed that the distinctive properties of myoglobin, or muscle hemoglobin, as he called it, are due to the globin portion of the molecule. The absorption spectra of myoglobin and hemoglobin are almost identical. According to Hill, myoglobin has its sharpest absorption band at 5800A, compared to 5770A for hemoglobin.

Figure 1 shows the myoglobin cycle and the development of the brown color. The cycle starts with No. 1, *myoglobin*, a purple-red compound in which iron is in the ferrous state. This compound is the one normally existing in uncut meats. If a freshly cut meat surface is exposed to air, oxygen is added, forming compound No. 2, *oxymyoglobin*, which is scarlet red. The reaction

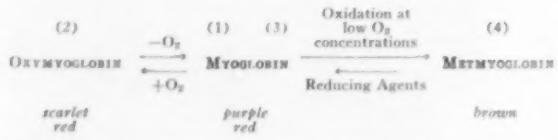

Figure 1. Color cycle in fresh beef.

is an oxygenation and not an oxidation. The iron is still in the ferrous state. If the supply of oxygen is cut off, myoglobin is formed again. On the diagram it is indicated as No. 3. Myoglobin is then oxidized to compound No. 4, *metmyoglobin*, a brown substance. This reaction is a true oxidation, as evidenced by the fact that iron is in the ferric state. The reaction takes place most rapidly at low oxygen concentrations (1-1.4 mm. Hg O_2 pressure), then decreases to a constant value at pressures above 30 mm., as shown by George and Stratmann *(5)*, for a temperature of 86° F. (30° C.) at a pH of 5.69. Brooks *(2)* reports a value of about 4 mm. Hg oxygen pressure for the maximum rate of methemoglobin formation at 32° F. (0° C.). At these low oxygen pressures approximately half the myoglobin is in the form of oxymyoglobin. For each mole of metmyoglobin formed, 2.5 moles of oxygen are used up.

Conant and Fieser *(4)* were the first to suggest that the oxidation of the red oxyhemoglobin and oxymyoglobin to their corresponding brown "met" derivatives might increase under environments of low oxygen pressure. Neill and Hastings *(11)* found a possible explanation in the case of hemoglobin. If reduced hemoglobin reacts with oxygen to form methemoglobin, increasing the oxygen pressure will decrease the concentration of the other reactant, hemoglobin, by the formation of oxyhemoglobin, and a minimum rate of oxidation might be obtained.

Although it is possible to reduce metmyoglobin back to myoglobin by the use of certain reducing agents (sodium bisulfite, sodium hydrosulfite, titanous tartrate, and β-anthrahydroquinone), as indicated by the short arrow in Figure 1, reducing agents are not used in packaging materials in this country.

METHODS

All meat samples were 2 in. x 3 in. x 1½ in. portions of lean top round steaks. Storage temperature was 35° F. (1.7° C.).

Exclusion of all oxygen. Glass plates were placed over the meat samples. Pressure was exerted on the glass to insure intimate contact. Both bloomed and unbloomed samples were used.

Low oxygen conditions. Meat samples were placed in a large desiccator containing water in the bottom. Nitrogen was passed through the chamber. The cover was removed momentarily at one-hour intervals to permit a small amount of oxygen to enter.

[a] Presented at the Fourteenth Annual Meeting of the IFT, Los Angeles, California, July 1, 1954.

Dehydration. Meat samples were placed in the open air in a refrigerated display cabinet. Samples were weighed at the beginning and at the end of the storage period.

Dehydration combined with browning. Meat samples were placed in a large desiccator containing $CaCl_2$ in the bottom. Nitrogen was passed through the chamber. The cover was removed momentarily at one-hour intervals to permit a small amount of oxygen to enter.

Oxygen permeability requirements. Meat samples were wrapped in the following films, using a drugstore wrap made secure with a small piece of "Scotch" tape:

Polyethylene—.001 in., .0015 in., and .002 in.
Cellophane—300 MSAT-80.

The cellophane was studied both with the coated side and with the uncoated side in contact with the meat. The wrapped samples were stored at 34-38° F. (1.7° C.) for 2 days. Frequent observations were made and ratings assigned.

Oxygen permeabilities of the above films were determined by the method of Landrock and Proctor *(10)*, except that pure oxygen was used as a sweep gas. The apparatus (Figure 2) was

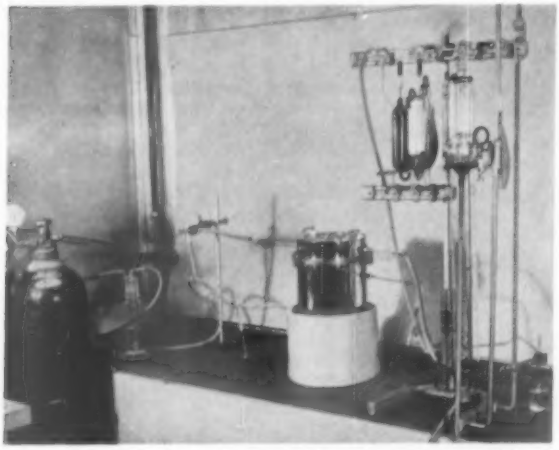

Figure 2. Apparatus for measuring oxygen permeability.

used in a room maintained at 75° F. (23.9° C.). The relative humidity of the uncoated side of the cellophanes (and of one side of the polyethylene) was held at approximately 100% by thoroughly wetting it before mounting the film, and by bubbling the nitrogen through water. A few milliliters of water were also kept in the lower chamber. The relative humidity of the other side was kept at approximately 52% by bubbling the oxygen through a saturated solution of $Mg(NO_3)_2 \cdot 6H_2O$. It was felt that this relative humidity was reasonably close to average ambient conditions.

Maximum display life under "optimum" storage conditions. Meat samples were placed in unsealed desiccators over water in order to provide an unlimited amount of air and to prevent the loss of significant amounts of moisture from the meat.

RESULTS AND DISCUSSION

With oxygen excluded by means of glass plates, meat samples required about 30 minutes before any brown discoloration began to appear. With the desiccator assembly it was expected that an oxygen pressure close to the 1-1.4 mm. Hg might be obtained. With this arrangement brown discoloration started to appear earlier and developed to a more intense brown than was the case where all oxygen was excluded.

Meat samples permitted to dehydrate in the open air began to turn a dark cherry red, and after 8 hours showed distinct signs of blackening, according to Urbain *(13)*. Such darkening is caused by a concentration of pigment. Dehydration of the surface of meat is therefore responsible for an intensification of color, rather than a discoloration. A moderately dark color in itself may not be objectionable, but it is associated with an excessive loss of weight. From the viewpoint of appearance, in the authors' opinion, a dehydration loss up to 4% of the total weight is not serious. Brooks *(2)* pointed out that a moderate increase in the intensity of color due to drying masks the change in hue caused by the change in hemoglobin. He also stated that hemoglobin appears to be oxidized more slowly in partly dried tissue.

In the experiment designed to show the effect of meat losing moisture rapidly while exposed to low oxygen concentrations, the meat turned to an objectionable dark reddish brown after 4 hours. The weight loss at this point was 5.26%. For equal exposure periods it was felt that the color of the meat was more objectionable than when dehydration or browning was allowed to take place, particularly where dehydration was extensive.

Another type of discoloration is seen in "dark-cutting" beef, a type of beef in which the purple-red reduced myoglobin color predominates, even after exposure to air. Such beef has a higher pH than normal beef. This rise in pH is caused by a decreased enzymatic breakdown to lactic acid as a result of a deficiency of glycogen. Hall, Latschar, and Mackintosh *(6)* showed that the demand for oxygen in "dark beef" is unusually high, and that oxymyoglobin is, as a result, robbed of its oxygen.

Bacterial action is also a factor in fresh meat discoloration. The meat is easily contaminated through cutting and handling, and the resultant population of bacteria may lead to the oxidation of myoglobin, as shown by Butler, Bratzler, and Mallmann *(3)*. These workers pointed out that the greatest increase in metmyoglobin formation is during the logarithmic growth phase. Hewitt *(7)* has shown that in this phase bacterial cultures will frequently use up all the available oxygen and actually cause reducing conditions to develop. Careful handling techniques will minimize these difficulties.

Light is not a factor in fresh meat color. Ramsbottom, Goeser, and Schultz *(12)* and Kraft and Ayres *(9)* showed that meat display case lighting did not discolor fresh red meats in storage periods up to 3 days.

A film suitable for packaging red meat must have a reasonably low water vapor permeability, and must be fairly permeable to oxygen. There is probably no lower limit on the water vapor permeability and, by the same token, no upper limit on the oxygen permeability. Other properties are also important, but are not pertinent in this discussion.

Cellophanes used for fresh meat packaging are unique in that they are coated with a moistureproof coating on the side to be kept away from the meat. The other side is left uncoated in order to permit the base cellophane sheet to become thoroughly wet with meat juice. Wet cellophane has a much higher permeability to oxygen than dry, and is capable of transmitting sufficient oxygen

to maintain bloom. The coating functions largely to prevent excessive passage of moisture and to permit the film to be heat sealed *(1)*.

One of the main purposes of this paper was to determine the oxygen permeability requirements for a suitable fresh meat film. This was done by measuring oxygen permeabilities, under simulated usage conditions, of films previously tried on meats. These films included one-side coated cellophane (MSAT-80) and polyethylenes of several gauges. Polyethylene was used in these studies solely for academic purposes, and for many reasons is not recommended as a commercial meat wrap film at this stage of development.

TABLE 1

Effect of oxygen permeability on meat color

Film	Oxygen permeability [1]	48 hour meat color rating
.001" polyethylene	13,000	Good
.0015" polyethylene	6,600	Good
300 MSAT-80 cellophane	5,500	Good
.002" polyethylene	4,400	Poor [2]
100 MSAT-80 cellophane (reversed)	2,400	Poor [3]

[1] ml. O_2/sq. met./24 hrs./atm. at 75° F. (23.9° C.) and 100% vs. 52% R. H.
[2] Fails within 24 hours.
[3] Fails rapidly.

Table 1 shows the results. It will be seen that meat samples wrapped in films with permeabilities above 5500 ml. O_2/sq. met./24 hrs./atm. maintained good meat color for 48 hours. Films with lower permeabilities gave poor results. Placing MSAT-80 cellophane with the coating in contact with the high humidity also gave poor results, showing the importance of using the "wettable" side next to the meat. It would appear that an oxygen permeability of approximately 5,000 or more is required for oxymyoglobin retention.

Along with knowing the oxygen permeability requirements for meat packaging films, it is also important to determine how long the meat can be kept under optimum conditions. In the experiment described, the meat was still acceptable at the end of 4 days, but at the end of the 5th day a gray-brown color and sour odor were prevalent. These changes can be attributed to enzymatic and bacterial action. It was felt that this 4-5 day period established a definite limit on the display life, even with an ideal packaging film.

It has been shown *(3)* that bacteria usually act upon fresh meat by (a) causing discoloration by increasing the rate of metmyoglobin formation, (b) producing off-odors, and (c) forming slime, in the order indicated. Voegeli, Brazler, and Mallmann *(14)* have shown that after 3 days of display time, the number of microorganisms found on packaged fresh meat is greatly increased.

SUMMARY

The causes of discoloration have been discussed. The most important of these is lack of sufficient oxygen to keep the bright red "bloom" of oxymyoglobin. Fresh red meat cellophanes such as MSAT-80 are especially designed to permit the passage of large amounts of oxygen through the film while in actual use with meat. The minimum oxygen permeability requirement is about 5000 ml. O_2/sq. met./24 hrs./atm. at 75° F. (23.9° C.) — 100% vs. 52% R. H. Under conditions where unlimited oxygen is available and where dehydration cannot take place, the meat breaks down as a result of enzymatic and bacterial changes so that it is no longer salable after 4-5 days.

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The Quantitative Determination of Small Amounts of Coumarin

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Since the recent ruling by the Food and Drug Administration of the U. S. *(1)*, declaring coumarin a toxic material and not suitable for use in foods, some less toxic substitutes have become available, the most important being dihydrocoumarin, a coumarin derivative. Recently a qualitative method *(2)* has been published for the determination of coumarin. This method is sensitive to less than 1 gamma (microgram) of coumarin. We have found that quantitative results can be obtained by a spectrophotometric method which is applicable for the analysis of compounds containing coumarin. If no interfering substance is present, the method is reproducible and accurate to at least 0.01% coumarin. This procedure is based on the measurement of the ultraviolet light absorbed at 335 mμ, the point of maximum absorption for an alcoholic KOH solution of coumarin. (See Figure 1).

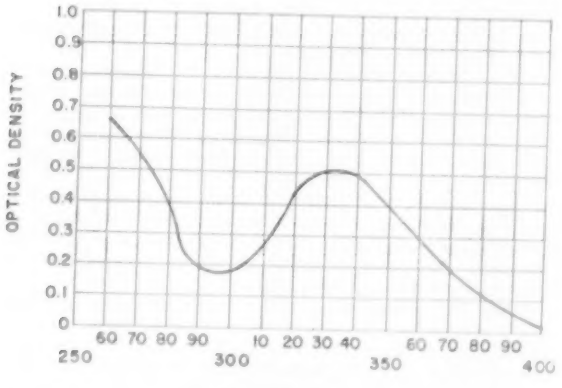

Figure 1. Ultraviolet absorption of coumarin at 335 mμ. (Solvent: 0.1 N KOH in 50% alcohol. Cell: 1.00 cm.)

PROCEDURES

Apparatus. Ultraviolet spectrophotometer. A Beckman Model DU is used in this laboratory.

Solvent. Approximately 0.1 normal KOH in 50% Ethyl Alcohol. Dissolve 6 g. of KOH in 500 ml. of distilled water. Dilute to 1,000 ml. with undenatured Ethyl Alcohol 95% by volume.

Procedure for the standard curve. Dissolve 1 g. of pure coumarin in 100 ml. of the solvent. Take 1 ml. of this solution and dilute to 100 ml. with the solvent. From this solution containing 0.1 mg. of coumarin per ml., take 25 ml., 20 ml., 15 ml., 10 ml., 5 ml., 2.5 ml., 1 ml., and 0.5 ml. aliquots and dilute each to 100 ml. with the solvent. Transfer each of the above solutions, containing from 2.5 mg. to .05 mg. coumarin per 100 ml. of solvent, to a 1 cm. cell and measure the optical density at 335 mμ. Plot the density against the milligrams of coumarin in 100 ml. of solvent. (See Figure 2).

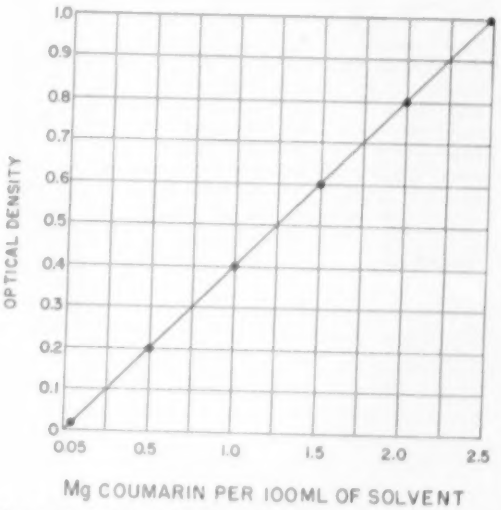

Figure 2. Ultraviolet absorption of coumarin at 335 mμ. (Solvent: 0.1 N KOH in 50% alcohol. Cell: 1.00 cm.)

Procedure for determining coumarin. Weigh from 0.1 to 10 g. of sample into a 100 ml. volumetric flask. Add approximately 75 ml. of the solvent and shake the mixture for a few minutes to dissolve, then fill the flask to the mark and mix by inverting several times. If necessary, filter a few cc. and transfer the filtrate to the 1 cm. cell of the spectrophotometer. Read the optical density at 335 mμ. From the standard curve, obtain the milligrams of coumarin and calculate the percent.

SUMMARY

A spectrophotometric method for the determination of coumarin is described. It has been successfully applied in this laboratory to the determination of small amounts of coumarin in 3, 4-dihydrocoumarin.

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Frozen Grapefruit, Tangerine, and Limeade Concentrates[a]

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(Manuscript received July 13, 1954)

The principal properties and problems of frozen grapefruit, tangerine, and limeade concentrates are discussed. Grapefruit concentrates are somewhat less stable, therefore heat treatment is used to improve cloud stability. Tangerines are fragile and irregular in shape and present problems in juice extraction and finishing. Lime juice may be merely sweetened in the preparation of concentrate for limeade or more concentrated products may be prepared by evaporation under low pressure and reinforcement of flavor with puree. Satisfactory frozen concentrates have been commercially prepared from all three types of fruit. Results of laboratory analyses are given for nine samples of grapefruit, three of tangerine, and eight of limeade concentrates.

Concentrated grapefruit, tangerine, and lime juices have excellent possibilities for commercial development even though they have not been packed to date in as large quantities as concentrated orange juice. When frozen concentrates were first developed, oranges were available in abundance and presented an excellent opportunity for exploitation. Because of the demand for frozen concentrated orange juice, equipment available for concentrating has been fully utilized during the citrus season on the orange product and there has been little opportunity to diversify into other comparatively untried frozen concentrates. Attention to these other citrus products is to be expected when adequate evaporating capacity has been installed. In this paper the literature describing the principal attributes of each type of concentrate is reviewed, some problems in industrial practice are discussed, and recent experiences in our laboratory, together with analytical data on commercial products, are reported.

FROZEN GRAPEFRUIT CONCENTRATE

Small commercial packs of frozen concentrated grapefruit juice have been prepared commencing with the 1947-48 season. The largest pack was in 1949-50 when a little over a million and a half gallons of concentrate were prepared. Since then the pack has ranged around a million gallons a year, all produced in Florida.

Frozen concentrated grapefruit juice has been prepared in plants designed for orange concentrate. The main equipment modification is that the juice extractors must be changed or adjusted so that the larger sized grapefruit can be handled. The juice is extracted in automatic machines, passed through finishers to remove seeds and excess pulp, and concentrated in falling film vacuum evaporators at a temperature not above 80° F. Concentration is continued until 50 to 55° Brix is attained and then fresh cutback juice is added until the density is reduced to 38° Brix or slightly above. The same strict sanitary measures are required as with frozen concentrated orange juice. Some cold-pressed grapefruit peel oil may be added to bring the recoverable oil level up somewhat but not over the 0.040 ml./100 g. of concentrate maximum permitted in the U. S. Grade A product. If sweetened concentrate is to be prepared, the sugar is added to the cutback juice or to the evaporator feed juice rather than to the concentrate, in which it does not dissolve readily.

Seeded varieties of citrus fruit including grapefruit, are generally found to be superior in flavor to the seedless varieties. The common Duncan grapefruit is preferred generally to the Marsh Seedless variety.

It was recognized rather early that grapefruit concentrate, especially from the seedy varieties, has a greater tendency to clarify and form gels than does orange concentrate. Present practice is to heat the evaporator feed juice to about 180° F. in order to reduce pectinesterase activity and provide cloud stability. The cutback juice is not heated.

Wenzel, Moore, Rouse, and Atkins *(17)* compared concentrates prepared from Hamlin, Pineapple, and Valencia oranges, Dancy tangerines, and Duncan and Marsh Seedless grapefruit after one month of storage. Concentrate from Duncan grapefruit showed greater tendency to gel at 40° F. and to clarify at 10° F. than the other concentrates.

Olsen, Huggart, and Asbel *(11)* found that concentrates from seedy grapefruit, prepared from juice extracted at high pressure, or containing large amounts of pulp, show more tendency to gel and clarify than do concentrates from juices extracted at low pressure and containing little pulp.

Rouse and Atkins *(14)* found that heating Duncan grapefruit juices of 10% pulp content in 0.8 seconds to temperatures of 195° F., 200° F., and 205° F. resulted in complete inactivation of pectinesterase enzyme when the pH values of the juice were 3.0, 3.5, and 3.8 respectively. In another study, Rouse and Atkins *(15)* found complete pectinesterase inactivation in Marsh Seedless grapefruit juice by heating in 0.8 seconds to 200° F., 205° F., and 210° F., respectively, for pH 3.0, 3.4, and 3.8.

Grapefruit has a distinctive flavor all its own, including a slight bitterness due largely to the presence of naringin. Bitterness decreases with increasing maturity. Excessive pressures during extraction or finishing tend to increase bitterness. Recently the Davis test for flavanones *(8)* has been found useful in establishing the settings for juicing equipment. This test has been in use by a few commercial canners of grapefruit juice and the Agricultural Marketing Service inspectors began to use it on an informal basis during the 1953-54 season. During the early part of the season it was noted that there was a direct relationship between bitterness and Davis test values and both could be controlled to a considerable extent by adjusting the extractors and finishers. However, later in the season high Davis test values were not necessarily associated with excessive bitterness. Flavanones other than naringin may be present. More information on the nature of the compounds responsible for bitterness and better methods of estimating those of significance are needed.

Pink and red grapefruit present additional problems in concentrate manufacture. These varieties have been popular in Texas and are found in increasing abundance in Florida. The pink and red fruit have found favor for fresh market uses and

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[b] Laboratories of the Southern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

seasonal surpluses will be available for processing. Although the whole or sliced fruit is very attractive, the juice extracted by usual commercial methods has a weak, "muddy" color. Huffman, Lime, and Scott *(10)* found that the color can be enhanced by incorporating some finely divided finisher pulp. This is done by taking the pulp from the usual juice finisher and passing it through a second finisher with a coarse screen to separate seeds and rag from soft pulp. The pulp is then finely dispersed in a colloid mill and added in the cutback juice. Excessive pulp can cause bitterness, but under proper control a distinctive pink color can be obtained without adversely affecting the flavor. This product is attractive and finds favor with those who have come to like pink and red grapefruit.

FROZEN TANGERINE CONCENTRATE

Tangerines have a distinctive tangy flavor quite different from other citrus fruit and are highly regarded among those familiar with them. Frozen concentrated tangerine juice can be made that has the typical flavor of this fruit. It was among the first frozen concentrates considered for commercial production along with the orange product. Cotton, Roy, Brokaw, McDuff, and Schroeder *(6)* studied the storage characteristics of tangerine concentrate and found only slight losses in flavor and vitamin C content during storage for a year at 0° F.

The preparation of tangerine juices and concentrates has presented difficult problems. Atkins, Moore, and Heid *(1)* reported on tangerine juice products in 1944. They had no particular success in preparing a satisfactory single-strength juice probably because of the method of juice extraction employed. Instead, they suggested using the juice to prepare a bland syrup. Curl *(7)* prepared tangerine juice by several methods and got the best results from juice prepared by simple squeezing of the fruit. He indicated that the material responsible for off-flavor development appeared to be associated with the suspended matter. He noted that in previous attempts to produce tangerine juice, a screw press had been used which macerated the pulp or peel and pulp. Extractives from them may have contributed to the rapid development of off-flavors. Shortly after these studies were begun a commercial pack of canned juice appeared on the market, and tangerine juice has been a commercial product since then.

Wenzel, Huggart, Olsen, Moore, and Atkins *(16)* and Wenzel, Moore, Rouse, and Atkins *(17)* reported that tangerines were best for concentrate in Florida during the months of January and February. Products prepared from fruit harvested in December were high in acid, low in Brix-acid ratio and were unfavorably rated as to flavor. Tangerine concentrates were observed to be lower in pectinesterase activity and showed less tendency to gel and clarify than orange or grapefruit concentrate. The use of high finishing pressure increased the tendency to gel and clarify. Gelation and clarification was less at high concentration; a concentrate of 68° Brix showed no clarification in three months at 60° F.

Rouse and Atkins *(2, 15)* included tangerine juice in heat treatment studies. Pectinesterase was completely inactivated in juice of pH 3.8 by heating to 210° F. in 0.8 seconds, to 205° F. in 3 seconds, to 200° F. in 6 seconds, and to 195° F. in 12 seconds.

Rouse *(13)* investigated the pectinesterase activity of the various parts of the tangerine. In the tangerine the highest activity on a dry solids basis was in the juice sacs followed in order by the rag, flavedo, albedo, seeds, and juice. The pectinesterase activities of orange and grapefruit juices included in the same study were at least ten times that of the tangerine juice. The pectin content of tangerine juice was also found to be much lower than that of orange and grapefruit juices. No doubt, these values are related to the greater stability of tangerine juice.

Tangerines are irregular oblate in shape, have a tender loose skin and the sections separate easily. These characteristics make it necessary to handle the fruit with more care than oranges or grapefruit. Tangerines should be harvested by clipping, as pulling is likely to remove some of the peel along with the stem (plugging) which opens up the center to decay and the entrance of wash water. Because of the danger of bruising or damage to the peel, fruit should be handled in fruit boxes or loaded in fruit trucks to a depth of not over two feet. The fruit should not be placed in the usual citrus fruit bins.

In the plant, tangerines are handled much the same as oranges. Adjustment of the machines is necessary to accommodate the smaller fruit but the yield of juice per extractor is only about half that obtainable with oranges. Extra extractors must be available or a reduction in plant capacity will be experienced. The fruit tends to fall apart easily and pieces of fruit along with a few pieces of peel pass from the extractor to the finisher. Because of this, special attention needs to be paid to the finishing operation. Since peel and pulp extractives can be injurious to flavor, the amount of peel going through the finisher should be kept to a minimum and the time between juice extraction and finishing should be kept as short as possible.

No difficulties are encountered in the remaining steps in preparing frozen concentrated tangerine juice. Low-temperature evaporators operate in a satisfactory manner and the use of cutback juice gives a typical tangerine flavor.

Tangerines are not as plentiful as some other citrus fruits, the average supply being about 5,000,000 boxes a year, about 1/25 the annual orange supply.

FROZEN LIMEADE CONCENTRATES

Until quite recently, limes have been mainly used fresh or processed for their peel oil. A limited amount of lime juice has been prepared for use in the bottled beverage trade. Lime oil will, no doubt, continue to be recovered because of its distinctive flavor and favorable market.

Lime juice is far too acid to drink straight and is used in the preparation of limeades or other beverages. One volume of fresh lime juice will make from 8 to 10 volumes of limeade. The possibility of a product which could be simply diluted with water has special appeal. It was found that such a product could be made by adding sugar to single-strength lime juice until the proper proportion of citric acid and sugar was attained. Such a product is marketed as "concentrate for limeade" and the demand for this product has been so great that much attention is being given to setting out new lime groves or budding other citrus varieties to limes. This product is similar in nature to "concentrate for lemonade," which has also found considerable favor.

Persian limes are handled in Florida in conventional orange juice extracting and finishing equipment, even though the fruit is not quite round. This variety contains 5-7% citric acid and must be sweetened to about 48° Brix in order to give the proper sugar-acid ratio. During the addition of dry sugar the volume increases about 50%. To prepare for use, one volume of this product is diluted with 4½ volumes of water. Vacuum concentrated lime juice may be used to standardize the Brix-acid ratio. Key or Mexican limes contain 7-8% citric acid. They are difficult to handle in conventional juice extracting equipment because of their small size. No completely satisfactory method of extracting juice from these limes has been found. It is difficult to prevent excessive oil content and objectionable bitterness. For a beverage, Griffiths, Lime, and Stephens *(9)* recommend the addition of sugar to 60-65° Brix to give a sugar-acid ratio of 15:1 to 16:1, and reconstitution with 5 volumes of water to one of the sweetened product.

Rouse and Atkins *(15)* included Persian lime juice (pH 2.4 and 6% pulp content) in a study of heat inactivation of pectinesterase in citrus juices and found that the enzyme was completely inactivated by heating the juice to 190° F. in 0.8 seconds.

Bissett, Veldhuis and Rushing *(4)* found that heating Persian lime juice (pH 2.38 and 8% soluble solids) to 160° F. in 17 seconds was sufficient to provide satisfactory cloud retention in the canned product in 35° F. storage. When sugar was added in sufficient quantity to prepare sweetened concentrate for limeade, the cloud largely disappeared and was therefore not susceptible to measurement as a criterion of the adequacy of pasteurization.

Olsen and Moore *(12)* observed that use of more than 30% dextrose in the sugar mixture added to lime juice resulted in

the formation of unsightly sugar hydrate in frozen storage. The amount of dextrose was considered the principal factor but heat treatment, seeding, type of container, and length of storage were also considered important in sugar hydrate formation.

Single-strength Persian lime juice has sufficient lime oil in it to give a satisfactory flavor to a limeade. During concentration much of the volatile oil is lost and cutback juice as commonly prepared contains insufficient oil to impart a desirable flavor to concentrate for limeade. Investigations by Bissett, Veldhuis and Scott *(5)* indicated a preference for 0.003 to 0.004% recoverable oil by volume in the diluted limeade. The addition of coldpressed lime oil to this level results in considerable improvement in flavor. Even more improvement is obtained by using lime puree prepared as described by Beavens *(3)*. Limeades prepared from concentrate and puree resemble those from fresh lime juice. Testing of experimental packs in the laboratory indicated a preference for limeades of Brix-acid ratios of 14:1 to 16:1. A preference was also noted for limeades of about 11° Brix. Based on this information, sweetened and unsweetened limeade superconcentrates were prepared in the pilot plant. One gallon of sweetened superconcentrate will produce eight gallons of beverage upon dilution with water, and one gallon of unsweetened superconcentrate will produce 35 gallons of limeade upon the addition of water and sugar. These products kept well in frozen storage for a year.

A typical formula for a sweetened 8-fold limeade superconcentrate consisted of about 0.42 gallon of 2.09-fold lime concentrate (12.7% citric acid), 0.06 gallon of lime puree (0.4% recoverable oil by volume), and 6.9 pounds of sugar. A typical formula for a 35-fold unsweetened superconcentrate consisted of 0.75 gallon of 5.12-fold lime concentrate (28.7% citric acid) and 0.25 gallon of puree (0.4% recoverable oil). To prepare a limeade, 30.2 pounds of sugar would need be added to one gallon of superconcentrate and water added to a total volume of 35 gallons. These products offer special advantages where storage space and shipping weight are critical factors.

ANALYTICAL SURVEY OF COMMERCIAL PRODUCTS

Several samples of frozen grapefruit and tangerine concentrate and concentrate for limeade were obtained in local markets and examined in the laboratory. The results of this examination are given in Table 1.

All cans were reconstituted as directed on the label, using the can as a measure. While this resulted in some variation in the Brix of the reconstituted product, it approximated actual usage.

Five of the samples of frozen grapefruit concentrate were labeled "unsweetened" (Brands B and D) and four "sugar added to standardize flavor" (Brands A and E). As far as Brix in can and Brix-acid ratio are concerned, the samples of Brand A can be classed in one group and all the remaining samples in another. Brand A samples ranged from 43.2° to 43.8° Brix and from 11.9:1 to 12.2:1 Brix-acid ratio. The others ranged from 39.7° to 40.5° Brix and 8.8:1 to 9.9:1 Brix-acid ratio. The ranges for all samples were 3.2 to 3.5 in pH, 0.001 to 0.005% in recoverable oil by volume, 6.0 to 11.0% in suspended solids, 1.9 to 18.1 in PE.μ/ml. x 10^4 (Brand D appears not to have been heated) and 31 to 44 mg./100 ml. in ascorbic acid.

The three frozen tangerine concentrate samples were quite similar. The major difference was the low oil content of one sample. No pectinesterase activity was noted and inquiry revealed the evaporator feed juice had been heated. Commercial operators stated that while no gelation had been observed, clarification had been encountered in distribution channels and heat was used to provide more cloud stability.

The eight limeade samples which had been prepared from Persian limes showed remarkable uniformity in Brix, acidity, and Brix-acid ratio. The range of Brix-acid ratio was from 13.2:1 to 14.9:1 and compares favorably with the 14:1 to 16:1 range of ratios considered best in our recent studies. At the same time eight commercial lots of concentrate for lemonade were tested and observed to vary in ratio from 13.2:1 to 18:1, averaging 15.8:1. Recoverable oil values varied from 0.0004 to 0.002% by volume — somewhat below the 0.003 to 0.004% by volume found desirable in the study of superconcentrated limeades. Suspended solids varied from 0.5 to 1.4% by volume. Of the six samples tested for pectinesterase activity, three showed no activity and three a moderate amount. The ascorbic acid values naturally reflect the dilution during the preparation of the product. Although limeade is not as potent as orange

TABLE 1

Analyses of commercial grapefruit and tangerine concentrates and concentrates for limeade

Product	Brand	Brix in can	Brix recon.[1]	Acidity citric[1]	Brix-acid ratio	pH[1]	Recov. oil[1]	Suspend solids[1]	Pectin-esterase[1]	Ascorbic acid[1]
		deg.	*deg.*	%			% *by volume*	% *by volume*	*PE.μ/ml. x 10^4*	*mg./100 ml.*
Grapefruit	A	43.2	12.6	1.06	11.9:1	3.5	0.002	6.0	4.0	42
Grapefruit	A	43.6	13.4	1.13	11.9:1	3.4	0.003	11.0	1.9	36
Grapefruit	A	43.8	12.6	1.03	12.2:1	3.5	0.001	6.0	2.8	41
Grapefruit	B	40.5	11.4	1.15	9.9:1	3.4	0.002	8.0	2.5	43
Grapefruit	B	40.0	11.6	1.31	8.9:1	3.2	0.001	9.0	3.3	43
Grapefruit	B	39.7	11.2	1.28	8.8:1	3.4	0.001	7.0	3.1	44
Grapefruit	D	40.4	11.6	1.28	9.1:1	3.4	0.005	8.0	15.1	44
Grapefruit	D	39.9	11.2	1.18	9.5:1	3.5	0.004	9.3	18.1	39
Grapefruit	E	39.9	11.6	1.18	9.8:1	3.3	0.003	6.5	2.7	31
Tangerine	A	41.4	11.6	0.86	13.5:1	3.6	0.008	9.5	.00	28
Tangerine	B	41.4	11.6	0.86	13.5:1	3.4	0.002	7.0	.00	25
Tangerine	B	42.7	12.2	0.93	13.1:1	3.7	0.008	5.5	.00	24
Limeade	A	47.9	10.9	0.73	14.9:1	2.7	0.0004	0.6	1.37	—
Limeade	A	47.8	10.0	0.73	13.6:1	2.4	0.002	1.0	1.45	3.6
Limeade	C	50.9	11.2	0.77	14.5:1	—	0.002	0.5	0.68	—
Limeade	C	50.2	10.2	0.77	13.2:1	—	0.0004	1.3	.00	2.3
Limeade	C	50.2	11.4	0.80	14.2:1	2.6	0.002	0.8	.00	1.8
Limeade	C	49.7	10.6	0.76	13.9:1	—	0.001	1.0	.00	1.3
Limeade	D	49.8	10.2	0.72	14.2:1	—	0.001	1.0	—	—
Limeade	D	51.3	11.0	0.77	14.2:1	2.7	0.002	1.4	—	2.4

[1] Results are given on reconstituted basis.

juice, it can contribute a considerable portion of the daily requirements of this vitamin.

Acceptable sugar-acid ratios for limeade and lemonade, as noted above, are well within the range of ratios allowed for U. S. Grade A frozen concentrated orange juice (11.5:1 to 18:1). However, the hydrogen ion concentrations of limeades tested (Table 1) average more than 10 times that of the tangerine juices listed or of typical orange juice. This is an indication that titratable acidity may be more important than pH in the acceptability of citrus beverages.

SUMMARY

Excellent frozen concentrates can be prepared from grapefruit, tangerine, and lime juices. Each kind presents distinctive problems in the manufacture of frozen concentrate.

The grapefruit product shows a greater tendency to gel and clarify in storage than does orange concentrate. To provide stability against deterioration heat treatment such as heating to 180° F. for a few seconds is commonly used. Frozen grapefruit concentrate of acceptable pink color can be prepared from pigmented grapefruit by separating some soft pulp and comminuting it with a colloid mill before adding it to the concentrate.

Since tangerines are quite fragile and irregular in shape, they must be handled with care to prevent damage, particularly in washing and juice extraction equipment. Tangerine concentrate has shown less tendency to gel and clarify than orange and grapefruit concentrates.

Lime juice because of its high acid content must be diluted and sweetened before it can be consumed. A frozen concentrate for limeade made from single-strength Persian and Mexican limes is already on the market. More concentrated products can be prepared from Persian limes by adding lime puree to concentrated lime juice. A sweetened limeade superconcentrate can be prepared, one volume of which requires dilution with seven volumes of water, or an unsweetened limeade superconcentrate which must be sweetened and diluted to 35 times its volume at the time of preparation for serving.

Data are presented showing the laboratory analyses of nine samples of concentrated grapefruit juice, three samples of concentrated tangerine juice, and eight samples of limeade for concentrate.

Acknowledgments

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Scheduling Plantings and Predicting Harvest Maturities for Processing Vegetables[a]

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To make the most economical use of labor and equipment in the vegetable processing industry, a steady flow of raw products from the fields to the factory is essential. Crop control programs are greatly affected by fluctuations in weather and must be adjustable to sudden changes. Plant growth and development are controlled by many interacting environmental factors, but of these, temperature is by far the most important. Research on temperature effects in the late twenties and early thirties gave rise to the effective accumulated heat unit technique which recently has been widely adapted by many canners and freezers of peas, sweet corn, and other vegetables. The basic research on which the heat unit method is based, the working details involved, and the merits and limitations of the technique are reported. Field departments, as well as management, have found the technique to be a valuable tool in spacing of plantings, timing of insect and disease control programs, predicting harvest maturities, and arranging for labor and supplies. Allied industries have found it useful in scheduling the manufacture and shipment of containers and other supplies.

Since temperature is the only growth factor considered, heat unit values in different areas and between seasons may vary. Recent research which offers explanations for some of the variations is reviewed and certain corrections suggested.

Many problems are encountered in scheduling plantings and predicting harvest maturities for processing vegetables. Crop production programs are usually based on an *average year*, but local weather fluctuates widely from the normal pattern and adjustments must be made as the season advances.

Numerous systems of scheduling plantings and predicting harvest dates of peas, sweet corn, and other processing vegetables have been used, but most of them have definite limitations. A system in general use for years was based on the number of days from planting to harvest *(37)*. Another was based on the interval from bloom to harvest. However, neither of these systems has been satisfactory as poor correlations exist between the number of days from planting to harvest and plant growth and development.

As a result of considerable basic research, a technique referred to as the "heat summation" or "heat unit" system was developed; it is now widely used by the industry in scheduling successive plantings and predicting the incidence of insect disease infestations, as well as in forecasting harvesting dates.

Although it is realized that plant growth is the result of the interaction of the plant to temperature, moisture, light intensity, length of day, fertility levels, and many other factors, and that any one of these may be a limiting or controlling factor, only the effects of temperature—a single growth factor—are taken into consideration in this system.

The theory of temperature summation as an index of plant growth, development, and maturity is not new. During the years 1913 to 1921, B. E. Livingston *(22, 23)* and co-workers published papers on the use of physiological temperature indices for the study of plant growth in relation to climatic conditions. These studies were followed in the late 1920's and early 1930's by the work of Appleman and Eaton *(3)*, Boswell *(7, 8)*, and Magoon and Culpepper *(12, 24, 25)*. Close relationships were shown between the time of development to a given stage in sweet corn and peas and the mean temperatures for that period. In these studies a summation of degree hours above a base temperature at which growth takes place correlated closely with plant development in both peas and sweet corn.

Based on the above studies and their own extensive investigations started in 1927, the Green Giant Company, Le Sueur, Minnesota *(1, 4, 33)* found that definite planting schedules could be formulated in advance of actual planting, and that harvest dates could be predicted with reasonable accuracy. In 1936 the method was adopted by most of their canneries and has been in use ever since. In 1945, the Green Giant Company made the general principles of the method available to the industry and since then many other companies have adopted it. Interest in the method has stimulated further investigations by can manufacturers *(28, 34, 35, 36)*, seed companies, research workers at several agricultural experiment stations *(9, 10, 13, 14, 15, 16, 19, 20, 21, 29, 30, 31, 32, 38)* and others *(11, 17,* and *27)*.

Definition of Terms

For each species of plant there is a minimum temperature at which growth takes place, a maximum temperature where growth ceases, and somewhere between these the optimum—the point at which the most active growth occurs. The minimum or base line temperatures for peas has been established at 40° F. and for sweet corn at 50° F.

To obtain the number of heat units in degree days, the maximum and minimum temperatures for the day are added together and divided by two to obtain the daily mean or average temperature. This daily mean temperature, minus the base line temperature equals the number of effective heat units for the day expressed as degree days. (The number of heat units expressed as degree hours is obtained by multiplying the number of effective heat units expressed as degree days by 24.) In this discussion, unless otherwise specified, heat units will be indicated as degree days.

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FORMULATION OF PLANTING SCHEDULES

The greatest benefit of the heat unit system is that it provides an effective basis for spacing successive plantings of a crop so that the cannery will have an uninterrupted supply of raw materials at their optimum maturity. In setting up the planting schedule, it is first necessary to obtain from the Weather Bureau the long-term average daily mean temperature records for the area. From these, a curve of accumulated heat units above the base line is constructed for the normal season from planting through harvest. (See Figures 1 and 2.) It is also necessary to know the daily cannery production capacity based on a 12- to 14-hour day. An extra shift can be added if climatic conditions or above average yields demand.

From the long term accumulated temperature curve and the predetermined cannery capacity, a theoretical planting schedule is developed and shifts in the theoretical schedule are made to compensate for irregularities in temperature during the planting season. Local temperature values are taken each day, and another curve of actual values is accumulated as the season advances to show variation from the normal.

In general, at harvest time of peas, about 30 degree days will be added each day. Therefore, plantings should be scheduled with an interval of about 30 heat units between each successive planting. For example, if a grower was able to harvest 5 acres per day and wanted to grow 15 acres of peas, he would not plant 5 acres a day on successive days as the peas would mature faster than he would be able to handle them. Under the heat unit system, if he planted 5 acres the first day, he would wait until 30 heat units accumulated (3 to 5 days) before planting the next 5 acres and wait then until approximately 30 more heat units accummulated before he made the last planting. Under this system, the respective plantings would reach the desired maturity in sufficient volume to take care of his capacity.

Each day during the planting season, a record of all plantings made the previous day is checked with daily accumulated temperatures, and a schedule for the next few days' plantings made. These plans are based on the prearranged schedule, weather at the time of planting, and the prediction from the official Weather Bureau 5-day forecasts. Should cold weather or heavy rains occur, adjustments in the schedule are made accordingly.

PREDICTING HARVEST MATURITIES

The heat unit system is of considerable value to both the field and factory supervisors in scheduling harvesting and canning operations, as fairly accurate estimates can be made as to starting dates and volumes of raw products to be handled within a given period.

Effects of location on forecasts. There is a definite need to determine the heat requirement in the area where the data are to be used. Although heat unit values for pea varieties that would apply over a wide range of conditions cannot be given, such values have been established for the major pea-growing areas. Seaton and Huffington *(35)* reported heat unit values representative for the north central United States (Table 1). Sayre *(32)* and co-workers in New York, established the varietal requirements (Table 2).

TABLE 1
Heat units from planting to 100 tenderometer for various pea varieties
(Representative for the north central United States)

Type	Varieties	Degree days above 40° F.
Alaska	Alaska, Super Alaska, Alah, Yukon, Rocket	1,200–1,250
Early Sweets	Alsweets, Pacemaker, Canaweet, Sweet Alaska, Early Harvest, Surprise, Surpass, Mardelah, Wisconsin Early Sweets, Crities 103, Ace, Early Badger, Loyalty, Lolo, Early Kay	1,200–1,300
Pride	Pride, Hardy, Canner King	1,400–1,500
Perfection	(Early)—Early Perfection, Resistant Early Perfection, Early Perfecta, Cascade, Climax, Bridger, Wasatch	1,500–1,575
	(Regular or late)—Perfection, Ranger, Commando, Dark-Skinned Perfection, Late Perfecta, Hyalite, Superior	1,575–1,650
Late Sweets	Profusion, Prince of Wales, Perfected Wales, Alderman, Bonneville, Miracle, Signal, Wisconsin Merit, Walah	1,625–1,725

Magoon and Culpepper *(25)* and Seaton and Huffington *(35)* reported that corn of an identical strain came to canning maturity with smaller temperature unit summations when grown in different latitudes. As a result, the larger canning companies with widespread operations are now making corrections in heat unit values for latitude differences.

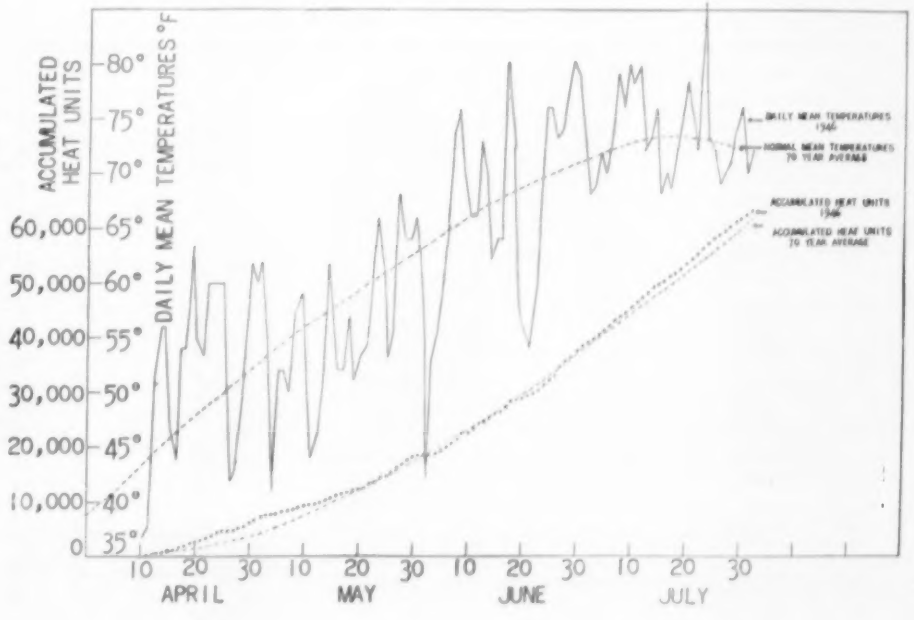

Figure 1. The daily mean temperatures from April through July for Madison, Wis. for 1946, and the 70-year average (normal) are shown by the upper two curves. Wide fluctuations occur between daily temperatures for a single season (1946), but are evened when the 70-year average is taken. The lower two curves show the heat unit accumulation above 40° F., for 1946, and the 70-year average. The 1946 season was near normal and the prediction made on the long-time average was essentially correct that season.

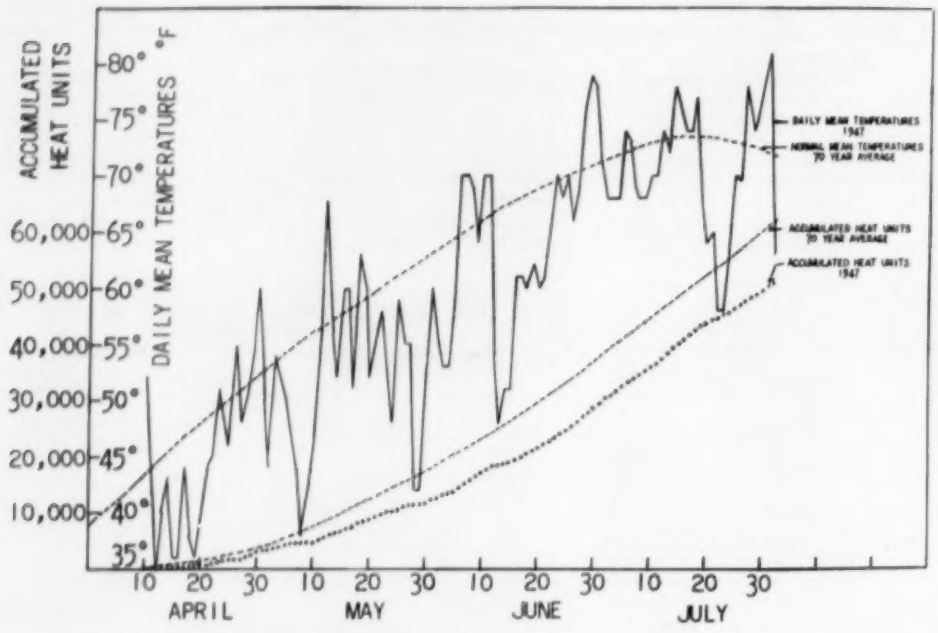

Figure 2. Same type of curves as shown in Figure 1, except that the values are for the 1947 season. Temperatures in 1947 were considerably below normal, and harvest dates as predicted from the normal curve were approximately ten days later as a result of the lower heat unit accumulation throughout the entire 1947 season.

Effects of variety on forecasts. From season to season total effective degree day units for a specific variety may vary slightly. For example, Sayre *(32)* at the New York Agricultural Experiment Station used a value of 1,350 degree days from planting to harvest maturity of 85 tenderometer for the Thomas Laxton variety. This value was 1,322 in 1953, and 1,349 on a different farm in 1952. Although slight seasonal variations in values for a given variety are encountered, the spread between varieties and plantings of the same variety has been found to be essentially the same. These inconsistencies have little effect on the effectiveness of the method.

Effect of soil, topography and other variables. Actual experience has shown that in most locations differences in soils, fertility levels, slope and similar variables may account for a range of ± 2 days of the predicted maturity date. (See Figures 3 and 4.) This amount of variation in the system is to be expected for any season. Compensation for it is made in planting schedules by doubling the acreage of the first planting. This provides a backlog on which to work. Variations among different fields are apparent at the time of bloom and can be readily determined in the pregrade samples taken 2 or 3 days before actual harvests.

Bomalaski *(6)* showed that peas planted early, when the soil is cool, require a lower heat summation for maturity than those planted later in the season. Variability in heat summations due to soil type and fertility, topography, and field stands, are reduced in the plantings made later in the season. In reporting the effects of combined heat and drought periods, Phillips *(28)* showed that peas failed to mature properly and had to be har-

TABLE 2

Heat unit and tenderometer values for pea varieties harvested at two maturities at Geneva, New York, in 1952

Variety	First harvest			Second harvest		
	No. of growing days	Total heat units degree days	Tenderometer field-run sample	No. of growing days	Total heat units degree days	Tenderometer field-run sample
Canning Varieties						
Pacemaker	61	1,288	93	63	1,349	114
Sweet Alaska	61	1,288	92	63	1,349	105
Tenex	61	1,288	93	63	1,349	114
Can Sweet	61	1,288	91	63	1,349	113
Surprise	61	1,288	90	63	1,349	107
Lolo	63	1,349	85	65	1,404	97
Ace	64	1,376	97	65	1,404	99
Bridger	68	1,514	98	70	1,582	118
Early Perfection	68	1,514	94	70	1,582	110
New Era	68	1,514	93	70	1,582	107
R. E. Perfection	70	1,582	85	71	1,621	115
Perfection	70	1,582	85	71	1,621	110
Superior	70	1,582	86	71	1,621	124
Shoshine	70	1,582	88	72	1,660	100
Freezing Varieties						
Early Freezer	61	1,288	90	63	1,349	103
Thomas Laxton	61	1,288	88	63	1,349	91
Thomas Laxton	63	1,349	85	65	1,404	95
Freezonian	63	1,349	88	65	1,404	98
Pluperfect	66	1,440	97	67	1,481	106
Wyola	66	1,440	90	67	1,481	101
Hyalite	67	1,481	86	68	1,514	86
D. G. Perfection	67	1,481	88	68	1,514	87
Perfected Freezer	67	1,481	88	70	1,582	100
Perfected Freezer	68	1,514	75	70	1,582	100

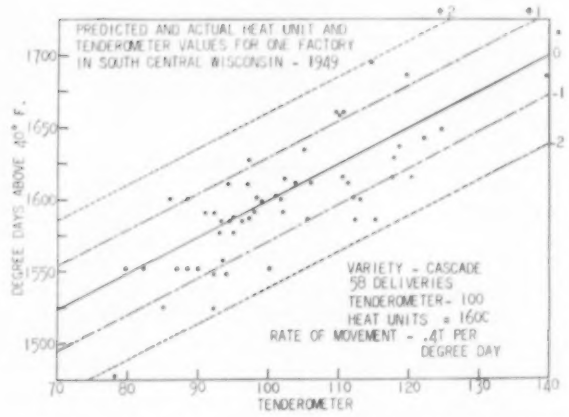

Figure 3. A test for goodness of fit for predicted increases in maturity by actual tenderometer values for 58 deliveries of Cascade peas to a Wisconsin cannery in 1949. No corrections were made for variations among the fields. The solid line shows the predicted rate of increase in maturity based on 1600 degree days from planting to 100 tenderometer and assumes the rate of increase for this variety to be 0.4 tenderometer per degree day. All but one of the 58 deliveries fall within ±2 days of predicted maturity and 72% of the values fall within ±1 day.

vested when the heat units were 10% to 20% below normal. Fletcher *(14)* working with several soil types in Pennsylvania concluded that from the canner's standpoint, air temperatures are significant enough for peas planted on different soil types if checked at several critical points in their development.

Correcting estimated forecasts. There is a definite relationship between blooming or silking dates and final harvests which provides a further check and an opportunity to correct estimated harvest forecasts 2 to 3 weeks before actual harvests. For example, most varieties of peas have a heat requirement of approximately 420 heat units above 40° F. from the time they reach 80% bloom until they reach a tenderometer reading of 100. Similarly, most varieties of corn require 500 heat units above 50° F. from 80% silking to reach prime canning maturity for whole kernel corn at 72% moisture. As a final check, at 350 heat units from 80% bloom, the fieldman begins pregrading or sampling the pea fields. Similarly, at 420 heat units after 80% silking, pregrades are taken in the sweet corn fields and tested for moisture content. These actual samples are the final check prior to harvests and when taken, the fieldman can make yield estimates of the respective fields.

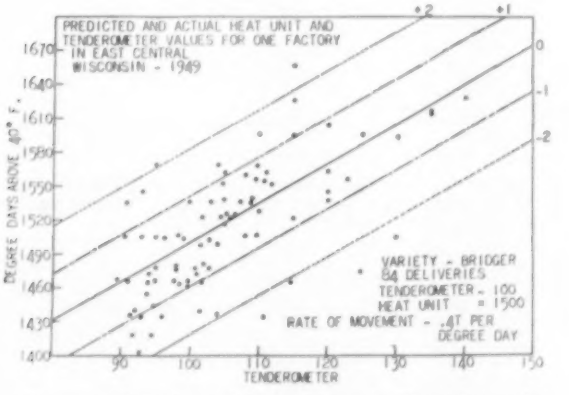

Figure 4. Same type of test as shown in Figure 3 covering 84 deliveries of Bridger peas to a Wisconsin cannery in 1949; 80% fall within ±1 day of predicted date and 94% within ±2 days of prediction.

MERITS AND LIMITATIONS OF THE METHOD

As stated previously, the heat unit system is based on only one of the many growth and development factors; namely, temperature above the point at which growth takes place. This is by far the most important element and over-shadows all others in its effects on the varieties of vegetables grown for processing in the United States.

Numerous articles have appeared recently to offer means for correcting the technique or to condemn it as not being an accurate measure of development and maturity. Some articles offer practical explanations for the slight discrepancies encountered while others seem to indicate a lack of understanding of the primary purpose of the technique.

The system is used to provide a means for scheduling plantings so as to provide an orderly flow of raw materials of optimum maturity to the cannery and to act as a measure of crop development. Apparently, some investigators are not familiar with the checks offered during the season such as time of emergence, time of bloom, and others that are operative. Seasonal differences which occur seem to affect all varieties and plantings equally. The system should be considered as a yardstick—not a micrometer—to be used along with other tools such as the microscope and the tenderometer.

In 1950, Seaton and Huffington *(35)* reported on an extensive survey of the heat summation system of crop control. Information was obtained from 75 companies operating 145 pea canneries and from 47 companies operating 93 sweet corn canneries in 19 states and 4 provinces in Canada, with combined acreages for the two crops exceeding 350,000 acres. In addition, 8 of the larger seed companies furnished records from their trial grounds. A total of 163 different varietal observations on 48 varieties of canning and freezing peas and 28 sweet corn hybrids were received.

The general consensus was that the heat unit system (a) made for more orderly harvests; (b) was a means for the prevention of bunching of harvests and the elimination of slack periods during the canning program; (c) was a definite aid in forecasting and setting up factory operations; (d) was a fairly accurate measure of performance of different varieties; and (e) was a definite aid in quality control.

Plotting varietal response to temperature accumulations as illustrated in Figure 5, revealed a rather uniform spread between varieties for any one location. Much the same type of curve was secured for the same varieties in different locations or geographic areas. The same varietal relationships held between varieties in any one location for different seasons. The inconsistencies in the various reports received seem to be attributable to variations in methods of temperature recording, latitude, elevation, soils, and other modifying factors. It was apparent that each company must of necessity establish its own values for its location and that it is not feasible to set a definite value for any one variety and expect it to be usable under all conditions.

Katz *(19)* experimented with the exponential index based on the supposition that plant growth rates follow

the rule of Van't Hoff and Arrhenius, doubling with each 18° F. increase in temperature, derived from the sum total of daily mean temperature efficiencies, where the daily efficiency U, is obtained by the formula:

$$U = \frac{(t-40)}{18} \quad \text{or} \quad \log U = \frac{\log 2(t-40)}{18}$$

Katz's studies were based on 3 years' records in Wisconsin and show (a) that essentially a linear relationship existed; (b) that the differences between the results obtained by using the direct summation and the exponential methods were small; and (c) that from year-to-year the difference between varieties was nearly constant and did not vary significantly.

Went *(39)* emphasized the fallacy of assessing equal importance to both day and night temperatures, as well as the importance of diurnal variations. Walls *(38)* suggests that more accurate results may be obtained if summations began, not at the planting date, but when

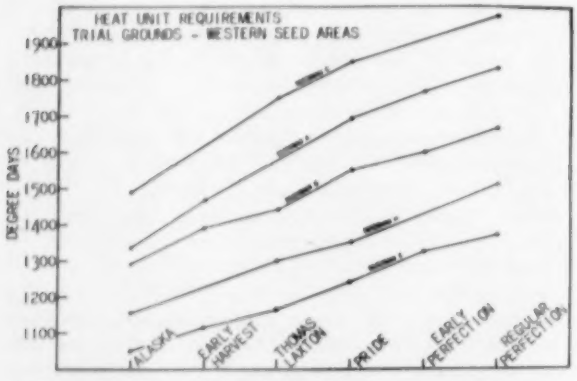

Figure 5. Heat unit requirements for several standard varieties of canning peas as reported by seed companies (A, B, C, E, and H) from records on their trial grounds in western seed-producing areas.

emergence of 60% to 75% of the plants occurred. Some canners use soil rather than air temperatures during the planting season and then change to air temperatures during the growing period. This seems to have some merit.

An excellent study, under controlled conditions, on the effects of temperature and photoperiod on the development of pea varieties was conducted in Michigan by Reath and Wittwer *(29)*. Pea varieties, representative of important commercial types, were grown in the greenhouse at 9-, 12- and 16-hour photoperiods each at 50° F. and 60° F. night temperatures and in successive field plantings. Observations as to days requisite to flowering, days to maturity, degree days from seeding to flowering, pod characteristics and vine heights suggest that both photoperiod and temperature have a marked influence. At 60° F. night temperature, Alaska and Surprise were day neutral with respect to flowering and pod production, but at 50° F. flowering was hastened by long days. Other varieties behaved as long-day plants at both 50° F. and 60° F. night temperature. In all mid-season and late pea varieties the number of degree days required for flowering was reduced progressively by exposure to 12- and 16-hour photoperiods. For field plantings the multiple of degree days summation and average length of daylight was found to be a less variable expression than the heat sum alone.

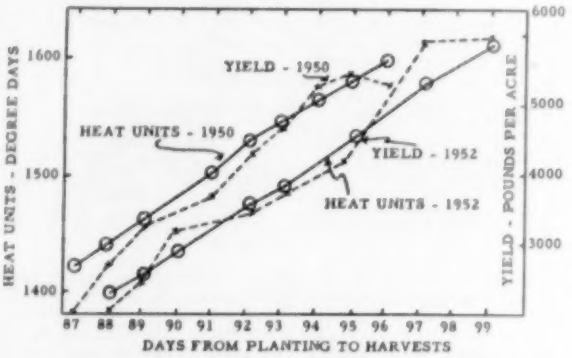

Figure 6. Data from Carstens (10) showing the relationship between daily increases in heat unit values and daily increases in yield of peas grown at Mount Vernon, Washington. (Compare with Figure 7.)

Unpublished data from Carstens *(10)* of daily pea harvests in 1950 and 1952 show the general relationships existing during the harvesting period between the daily increments in heat units, yield increases and maturity as measured by the tenderometer. (Figures 6-7.) While the number of samples reported is limited and insufficient for calculation of curvilinear regression, the data indicate: (a) the daily heat unit accumulation during harvest is a straight line function; (b) the daily yield increases are closely related to heat unit values but fall

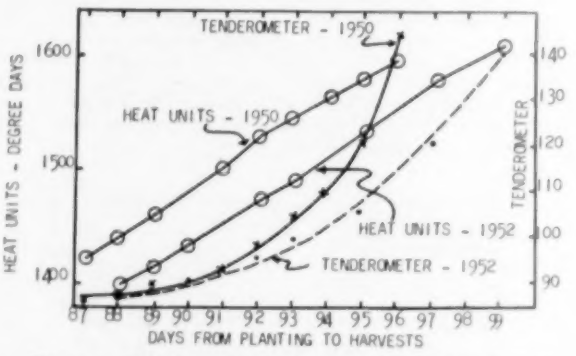

Figure 7. Data from same plots as shown in Figure 6, showing the relationship between daily heat unit increases and maturity in peas as measured by the tenderometer.

off with advanced maturity; (c) the tenderometer values show a definite curvilinear relationship with advancing maturity; and (d) the daily rate of change in tenderometer values is relatively slow between 85 to 100 but quite rapid beyond 100.

Variations in accumulated effective temperature requirements from planting to harvests for sweet corn between locations, between seasons and time of planting

for a single season are apparently of greater magnitude than those reported for peas. Huelsen *(18)* describes 5 temperature indices as means of forecasting maturity and concluded that the degree-hour summation method, although subject to error, is apparently the only one of practical use. The results of over a 13-year period with hybrid sweet corn strains reported by Lana and Haber *(20, 21)* further substantiate merits of the heat summation system.

Investigations with sweet corn on organic soils in Michigan reported by Davis *(13)* show the number of days to maturity to be influenced by season, varying as much as 20 days in successive seasons (1949-1950). Heat units were recorded at 4 levels: 8 inches above the surface, at soil level, 3½ inches below the surface, and 7½ inches below the surface. There was fair agreement at each level between the number of heat units required to mature the crop with different dates of planting and with different seasons, any one of which may be used in calculating the number of heat units required by a particular variety.

Gould and co-workers *(16)* in quality evaluations of fresh, frozen, and canned yellow sweet corn used accumulated growth degree days as a measure of maturity in their correlations with various yield and quality factors. Correlations (r values) of +0.684 were obtained between growth degree days *vs.* percent cutoff; —0.646 degree days *vs.* Succulometer; +0.916 degree days *vs.* A. I. S.; and +0.882 degree days *vs.* Soluble Solids. All of these values were significant to the 1% level.

System found useful in estimating can requirements. For several years Continental Can Company has used the heat unit system as an aid in planning manufacturing and shipping schedules for pea and corn cans in Wisconsin and other areas. Near the end of the planting season (mid-May), key customers in representative areas supply data by variety on the acreages planted each day. Temperatures are acquired from representative weather stations in the areas, and the anticipated daily can requirements, based on average yields during the canning season are calculated and plotted as shown in Figure 8.

As the season advances, the original forecasts are corrected weekly for prevailing temperatures, as shown in Figure 9.

These samples represent approximately 35,000 to 40,000 acres of peas or roughly the equivalent of 85 to 100 million 303 x 406 size cans. The value of the heat unit system in scheduling production is apparent.

Forecasting the incidence of insect and disease attacks. According to Miller *(26)*, the forecasting of plant disease occurrence on the basis of known weather relations is well established in this country. Forecasting of the incidence of certain diseases has been regularly a part of the control program in one region or another for nearly 30 years and includes such diseases as bacterial wilt of sweet corn, wheat leaf rust, late blight of tomatoes and potatoes, tobacco blue mold, cucurbit and lima bean mildew and others.

Observations on the incidence of sweet corn bacterial wilt and a study of weather records revealed that severe infections followed unusually warm winters and were scarce or absent after average or cold winters. It was found that a summation of the average temperatures for

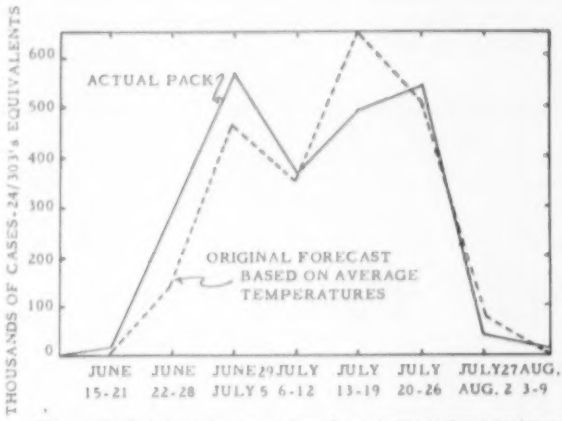

Figure 8. Original forecasts based on average temperatures and actual packs by weeks for 10 canneries in Wisconsin in 1953. A total of 17,826 acres of peas and a total pack of 2,287,607 cases of 24/303's equivalents are represented.

December, January, and February would show very accurately whether or not the disease could be expected during the following season and how much damage it would cause. If this temperature index is 100 or above, the disease will be destructive; with lesser sums the incidence is correspondingly less severe. Since this relationship was established it has been found that it depends upon the winter survival of the insect vector, the corn flea beetle. Based on this knowledge, Boewe *(5)* and others now make annual predictions for use by

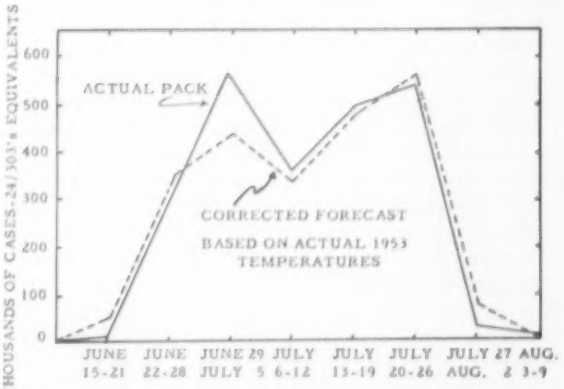

Figure 9. Forecast shown in Figure 8, corrected for 1953 actual temperatures and actual pack by weeks.

processors. When severe infestations are indicated, resistant types may be planted.

For several years, canners in the north central states —under the guidance of J. W. Apple of the University of Wisconsin—have been using the heat unit procedure for scheduling sprayings of agricultural chemicals for the

control of corn borers. Apple's *(2)* technique consists of recording as degree days all temperatures above 50° F. occurring in the spring and during the growing season and correlating them with the developmental stages of the insect. The accuracy of Apple's technique is revealed by data accumulated over 3 seasons in northern Illinois and 3 seasons in south central Wisconsin (Table 3).

TABLE 3

Degree day accumulation above base 50° F. for appearance of various stages of corn borer

Appearance	North Central Illinois			South Central Wisconsin			Average	Standard deviation
	1946	1947	1948	1949	1950	1951		
Pupa	243	252	258	238	256	230	246	±11
Moth	446	409	423	338	450	.....	423	±26
First generation								
Eggs	554	493	640	633	620	680	603	±67
Hatch	649	579	736	730	742	759	699	±70
Pupa	.....	.....	.....	1409	1490	1448	1446	±45
Moth	.....	1625	.....	1760	.....	1764	1716	±79
Second generation								
Eggs	1724	1717	1827	1830	1780	1847	1787	±57
Hatch	1849	1855	1969	1900	1885	1947	1901	±49

SUMMARY AND CONCLUSIONS

Considerable planning by the processor and his field department is required to assure the adequate and dependable supply of raw products imperative for a successful vegetable canning or freezing operation. A well-planned field production program must take into account the uncertainties of the weather and attacks of insects and plant diseases. From the knowledge accumulated by research, some of the interactions between the plant and its natural enemies, climatic and other factors have been established. Certain techniques quite widely adapted by industry for arranging planting schedules, predicting crop development and maturities, as well as predicting the incidence of insect and disease attacks have evolved.

It is not very likely that predictions can be entirely correct. This is just as true of forecasts of crop maturities as of weather or political elections or anything else. The possible accuracy of such forecasts depends upon the complicity of the critical periods and on how far in advance they are operative. Useful predictions can be made without knowing all the reasons for the observed reactions to weather, and even conditional forecasts will be helpful. Obviously, however, the more that is known about the importance, operation, and timing of factors favoring or inhibiting plant development and the longer ahead of time that weather can be known, the more accurate the predictions will be and the earlier they can be made. Improvement in and extension of the long-range weather forecast is the answer to the latter need.

More factual information is also needed on the relationships between and corrections for accumulated heat units above a base temperature, and other climatic factors such as optimum and maximum temperatures at which accumulated temperatures are operative, length of day, light intensities, latitude, and altitude, and edaphic factors such as soil type, soil moisture levels, soil nutrient levels, and related phenomena.

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Notes and Letters

New Russian Food-processing Machinery[a]

As part of its current drive to increase consumer goods production in the Soviet Union, the Russian government is increasing emphasis on the production of new machinery for manufacturing food products. Recent articles in *Planovoye Khoziaistvo (Planned Economy)*, organ of the central planning board of the Soviet government, describe some of the new equipment being introduced.

Especially notable, apparently, have been improvements in machinery employed in the baking of bread since the war. According to a table published in *Planned Economy* (July-August, 1954), there had been a 5-fold increase over 1940, by January 1, 1954, in the use of conveyor ovens in Soviet bakeries; a 2.6-fold increase in the use of dough-kneading machines; a 2.7-fold increase in sifting machines; and a 4½-fold increase in dough-making machines. One should bear in mind, of course, that these increases are based upon extremely low production figures before the war. Soviet authorities do not wish us to know the actual figures and shroud their claims in percentages—even in their publications for their own people. When an industry is in the infancy of its growth, even modest increases in the number of machines turned out will look stupendous if stated in percentage terms. Since January 1, 1952 there had been increases, by November 1, 1953, of 56% in conveyor ovens; 7% in dough-kneading machines; 115% in sifting machines; and 30% in dough-making machines. It is said that bakeries have been designed in which the products are manufactured "under sanitary conditions without the touch of human hands."

FOOD MACHINERY BY COMMODITY GROUPS

Meat packing is being modernized by the installation of conveyors for cutting the meat, automatic machines for separating it into portions and putting it into cans, automatic production lines for the preparation of frankfurters, sausages, and meat "dumplings." *Planned Economy* for March-April 1954 claims that the frankfurter production lines produce 10 tons per shift, release 35 workers, and "triple the capacity of the reconstructed enterprises." It is admitted that the meat dumpling lines are not yet organized as a complete unit, but when they are completed it is expected they will quadruple production and increase labor productivity perhaps as much as 10-fold. An automatic machine for making the dumplings is said to be able to turn out up to 500,000 dumplings in a shift. It is stated that the complete production lines should include continuous quick-freezing apparatus and devices for packing frozen meat dumplings in packages.

Conveyors are said to have been created for processing poultry which can save the labor of 40 persons per 3,000 head processed, and cut costs in half, but this technique has not been introduced into all poultry-processing firms because of lack of equipment.

Sugar. A number of semi-automatic machines are reported to have been installed in sugar-refining plants. In the Soviet Union these are mostly beet-sugar plants. Filtration of juices

[a] The author is grateful for the assistance of Professors Alvin I. Nelson and Marvin P. Steinberg, of the University of Illinois Food Technology Department, in explaining some of the technical processes described here and in suggesting an apt English equivalent, here and there, for some of the Russian expressions.

on frame filter-presses, in the first and second purifications, has been mechanized, *Planned Economy* notes, with the aid of a vacuum-filter, drum-type, continuous process. Effort is being made to extend this process to newly constructed and reconstructed plants and to complete work quickly on the designing of continuous-process centrifugal machines.

The Russians say they have had experience with continuous-process diffusion of the horizontal-rotary type and are familiar with types of vertical screw-conveyor diffusion. Methods are available for extracting white sugar from the feeding-molasses by-product of beet-sugar refining by a lime precipitation process, but equipment has not yet been manufactured to make this possible. An appeal is made to the Ministry of Machine-building to do this. It is estimated that 2% of the sugar content of beets is lost because of failure to extract it from the feeding molasses. Machine designers are also called upon to devise equipment for the manufacture of lump sugar.

Various automatic machines are reported as in use for the production, dividing, packaging, and wrapping of confectionery, dairy products, macaroni, vegetables, and fish.

Confections. In the manufacture of caramels continuous production lines are eliminating all handling by hand. An apparatus has been designed for stuffing candies with fruit filling. The research institute of the confectionery industry is carrying on work leading to the mechanization of the manufacture of candied fruits. A machine has been designed to mix dough for sugar pastry.

Dairy products. Creameries are introducing continuous-action butter-making machines and machinery for washing bottles, filling milk, etc. A new method of making butter is reported being introduced by which butter can be manufactured in 40 minutes, instead of 18 hours by previous methods, in a continuous production line, in sanitary, closed machinery; 150 of these outfits were supposed to have been installed in creameries in 1954. Refrigeration units with a total storage capacity of 438,000 tons were brought into use in the meat and milk industries between 1946 and 1952, it is reported.

Oils and fats. In the manufacture of vegetable oils and other fats the old hydraulic presses are being "rapidly" replaced by modern extractive equipment, including continuous-action screw presses. Three-quarters of the vegetable oil factories are reported as now equipped with this machinery.

Cereals. A new system is being developed for storing and transporting flour without the use of bags. This system is not clearly described in the March-April (1954) issue of *Planned Economy* but it is stated that its introduction has been delayed because of lack of equipment to manufacture the necessary machinery, which is said to include "pneumatic transport . . . from mill to bakery" and automatization of bakeries "in cooperation with the flour mills."

IN SUMMARY

Summarizing the progress to date in the mechanization of Soviet food-processing, *Planned Economy* notes that the stock of automatic and semi-automatic machines was 10 times larger in 1950 than in 1940, but the comment at the beginning of this article—that percentages can be misleading—should be kept in mind. About 10,000 new machines are said to have been introduced since 1940. In the first 3 years of the Fifth Five Year Plan (1951-53) 14.5 billion rubles were spent on the reconstruction of old and the construction of new food enterprises, out of 26 billions of capital investment allotted to the food industry for all the post-war years. These small investment expenditures compare with a total capital investment in the entire Soviet economy of around 430 billion rubles in 1951-53. The 14.5 billions invested in the food-processing industry in 3 years is about the same amount as the Soviet government ordinarily spends in one year for the administrative costs of government.

The tasks set for the 3 years 1954-56 include the construction of 144 meat-processing plants, 720 butter and cheese factories, 25 granulated sugar factories, 372 mechanized bread bakeries. The machine-building ministry must, it was planned, "install 530 million rubles' worth of technological equipment for the foodstuffs industry in 1954, and 800 million rubles' worth in 1955. It must organize the production of 200 new types of machines and automatic production lines." The food products industry itself was scheduled to spend 8.5 billion rubles in 1954 on all its activities.

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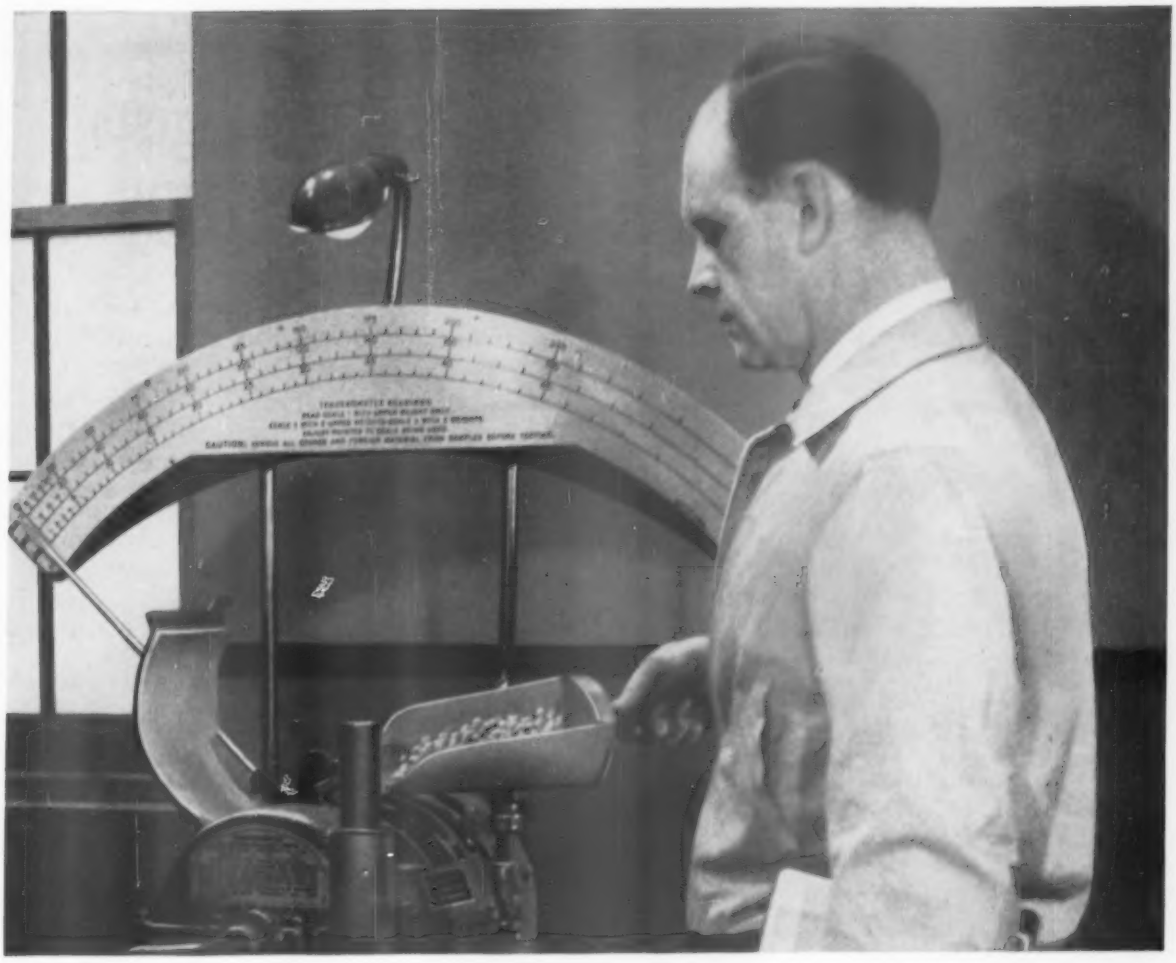

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INDIANA, No. 20: Chairman, V. R. Rupp. Secretary, Verna McCallum, 941 N. Meridian, Indianapolis 6, Ind. Councilor, N. W. Desrosier.

PITTSBURGH, No. 21: Chairman, V. W. Vaurio. Secretary, Frank J. Barry, H. J. Heinz Company, 1060 Progress St., Pittsburgh 30, Pa. Councilor, H. L. Lang.

BRITISH COLUMBIA, No. 22: Chairman, D. H. Dougans. Secretary, William E. Pearson, Lucky Lager Brewing Co., 210 Brunette St., New Westminster, B. C., Canada. Councilor, I. F. Greenwood.

AUSTRALIA SOUTHERN, No. 23: Chairman, J. E. Rice. Secretary, Kevin B. Smith, Southern Can Co. Pty. Ltd., 240 Geelong Road, West Footscray, W-11, Victoria, Australia. Councilor, M. K. Paxton.

MEMBERSHIP

Write to nearest regional secretary, if within an area covered by a regional section, or to the Executive Secretary of the Institute for an application form and information regarding qualifications and classifications.

Here are the answers to your questions...

Here's a new technical bulletin that gives you the complete lowdown on today's food grade antioxidants. Interesting competitive performance tests, graphs, and case histories illustrate just how other popular oxidation inhibitors stack up against **dbpc**® antioxidant, chemically known as di-tert-butyl-para-cresol, or butylated hydroxy toluene.

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. . . in the public interest

If there could be any doubt of the importance industry and government attach to organized research and development consider these figures. In 1920, about 10,000 persons were engaged in research totaling $29,000,000. By 1940, research personnel increased to 70,000 and expenditures amounted to $234,000,000. Today, some 350,000 people are working in research and the annual outlay has soared to 4 billion. So says *Industrial Research Newsletter*, January 1955, published by the Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Ill.

◆ ◆ ◆

A $15,000 grant from the Colgate-Palmolive Company of Jersey City to the Rutgers University Bureau of Biological Research to expand fundamental studies of the effectiveness of various therapeutic agents was announced by Dr. Lewis W. Jones, Rutgers president. The research award supplements a previous $5,000 grant to help the Bureau enlarge its work with radioisotopes. Radioisotopes will continue to be one of the major tools used in these studies. Dr. J. B. Allison, Bureau director, explained that through this kind of cooperation the University is able to pass on training and know-how in basic research that will be of permanent value to the industry involved, while at the same time University scientists will have a better idea of the problems industry seeks to solve and the basic knowledge needed to solve them. Colgate-Palmolive, he pointed out, will also assign one of its own research scientists to work with university scientists and students in the development of fundamental research.

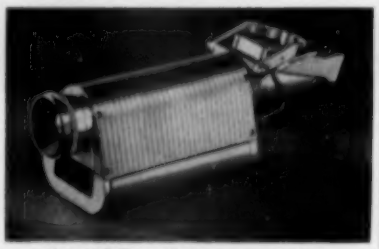
◆ ◆ ◆

Gay Paree may be recognized by some as a seat of culture, but as for its food, it has to take a back seat. Theodore R. Sills, of Chicago, a food publicist, just returned from a European trip, is convinced the top restaurants in Miami, Chicago, New York, San Fran-

(Continued on page 36)

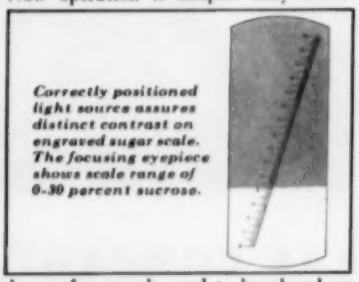
When to Pick or Pack? *Know in Seconds!*

New AO Hand Refractometer Determines Dissolved Solids Instantly!



New AO Hand Refractometer with anodized aluminum finish

Here's real news for food processors and growers! With AO's new Hand Refractometer accurate readings of the percentage of dissolved, solids, particularly sucrose, are made on the spot . . . instantly! Gone is the need for any reference to a thermometer or to temperature correction tables. The secret? AO's design engineers have simplified the temperature correction procedure by means of an exclusive, internal compensating device. Now operation is simple. Only a few drops of a sample need to be placed on the surface of the measuring prism. Using either transmitted or reflected light, the refractometer provides *immediate readings* from an internal graduated scale (range: 0-30 per cent sucrose) which is visible through the focusing eyepiece. Accuracy is assured to 0.1 percent.



Correctly positioned light source assures distinct contrast on engraved sugar scale. The focusing eyepiece shows scale range of 0-30 percent sucrose.

A built-in light source assures ideally positioned illumination under all conditions. Made of anodized aluminum, the new refractometer is light weight, easy to clean. An ever-ready top grain leather carrying case permits use of instrument without removal from case.

If you test raw products for ripeness; if you process fresh juices, syrups, tomatoes, etc., write Dept. P 190, American Optical Company; Buffalo 15, New York, for complete information on the new Refractometer. Ask for CATALOG L20.

Light wherever you go! Opening on underside of carrying case shows thumb button for built-in light source

American Optical

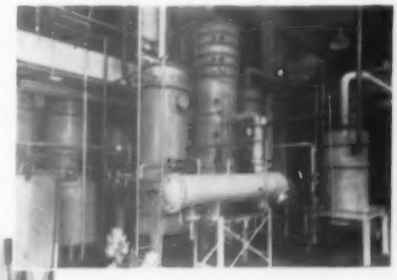
INSTRUMENT DIVISION, BUFFALO 15, N. Y.

SOLUBLIZED *Pepperoyal*®

Hi-Fi Flavor

In seasonings, as in recorded music, "HI-FI" denotes a definite and enjoyable difference in quality.

Compare Griffith's Solublized PEPPEROYAL with any soluble pepper. Compare it for purity of flavor! . . . for potency of flavor! . . . for uniformity of flavor! You'll find the flavor of PEPPEROYAL exceptional—constantly and exclusively "HI-FI" in quality. That's an important advantage to you as a user.



"High Fidelity" Flavor naturally comes from prime quality spices. But, its real distinctiveness originates here with The Griffith Laboratories' exclusive process of controlled flavor extraction.

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In Canada—The Griffith Laboratories, Ltd.

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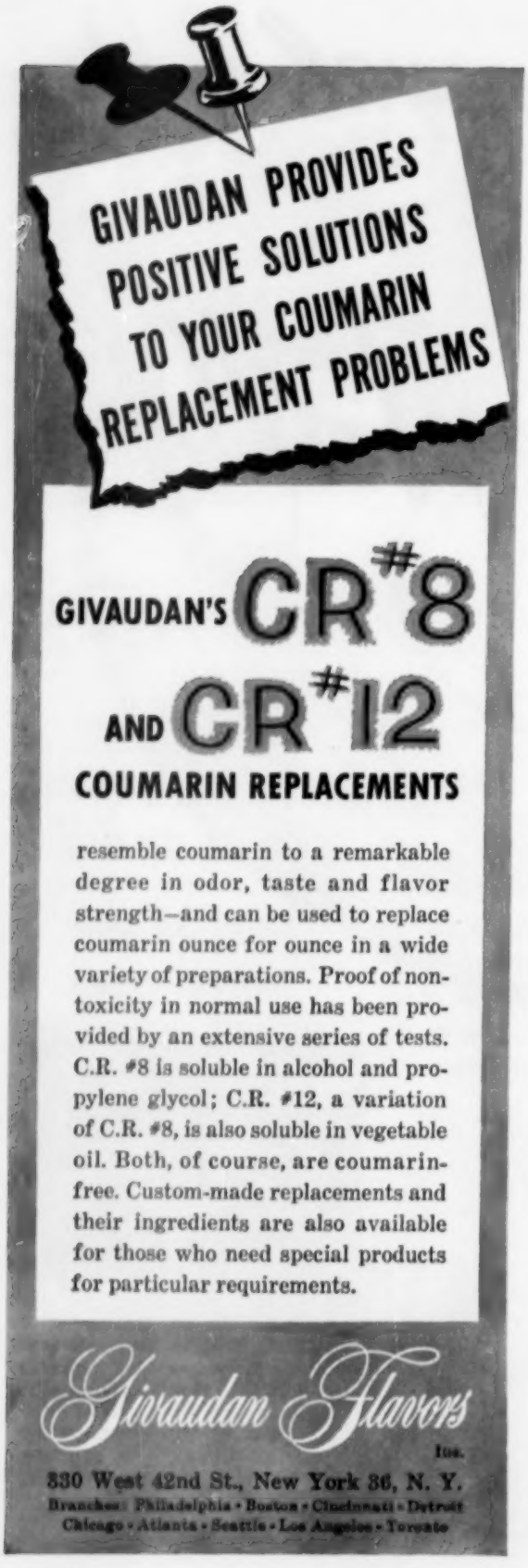
Laboratorios Griffith do Brasil, S. A. — Caixa Postal 300 Mogi das Cruzes, Est. S. P., Brasil.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resemble coumarin to a remarkable degree in odor, taste and flavor strength—and can be used to replace coumarin ounce for ounce in a wide variety of preparations. Proof of non-toxicity in normal use has been provided by an extensive series of tests. C.R. #8 is soluble in alcohol and propylene glycol; C.R. #12, a variation of C.R. #8, is also soluble in vegetable oil. Both, of course, are coumarin-free. Custom-made replacements and their ingredients are also available for those who need special products for particular requirements.
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DONOR INCREASES FLORASYNTH FELLOWSHIP AWARD TO ONE THOUSAND DOLLARS

Announcement has just been made by the donor that the stipend accompanying the Florasynth Fellowship Award has been doubled, from the present $500 a year to $1000. The increase goes into effect immediately.

The Award is made each year to a student in Food Technology in a recognized college of the United States or Canada. Nomination for the Award is made by the head of the department who supervises the work of the candidate. Applications for the 1956 award must be in the hands of the Secretary, Institute of Food Technologists, 176 West Adams St., Chicago, not later than February 1, 1956.

Any young man or woman, under 35 years of age, who has outstanding qualities of character, has demonstrated scientific or engineering ability, and who is a senior or graduate student in Food Technology in a recognized college is eligible for the Award. Present holder of the Award is Mr. John E. Schade who is enrolled in Food Technology at the University of California, Davis.

FOOD INDUSTRY TOPICS

(Continued from page 34)

cisco, and Los Angeles are far superior to the so-called continental cuisine found in Paris and to the famous restaurants of London. "Restaurants in Spain are a different matter," Mr. Sills pointed out. "Their food preparation, seasoning, and service outclass anything I found in France or England. Spanish pastries have it all over the French variety."

◆ ◆ ◆

Approval of consumer-unit packaging by wholesalers as the best method of merchandising fresh produce, and development of a simple, inexpensive automatic machine for packaging at stores are milestones in the development of the produce industry, according to Albert S. Allen, packaging authority of the Du Pont Company. "It is significant," he stated, "that approval of consumer-unit packaging now comes from a large segment of the produce industry formerly uncommitted to it—a group used to handling produce in the original shipping container." The machine hailed by Mr. Allen, developed by a group of lettuce growers, automatically wraps lettuce, broccoli, cauliflower, grapes, and other produce items.

◆ ◆ ◆

It would take billions of meat balls to accompany the volume of macaroni products consumed by Americans in 1954. Mr. Robert M. Green, director of the Nat'l. Macaroni Institute, Chicago, reports that the macaroni industry did about $253,000,000 worth of business in the past year.

◆ ◆ ◆

The fact that 70.8% of shoppers make their buying decisions in the store is of vital importance to the packer, states Mr. Seymour Oppenheimer, president of Tee-Pak Inc. (formerly Transparent Package Co.), 3520 S. Morgan St., Chicago. This figure, obtained in a recent Du Pont Company survey covering 5,338 shoppers in 250 representative supermarkets in 35 cities, indicates today's package must stop the cus-

(Continued on page 38)

UTILITANKS: 1,000 to 5,000 gallons.

CHEMSTOR tanks: 750 to 35,000 gallons.

Store up to 35,000 gallons

for as little as 25c per gal.

Glassed *inside and out*, UTILITANKS* store inert products like liquid sugar, tannic acid, etc.

Glassed both inside and out, the UTILITANK (storage tank) won't rust, will never need painting. Think what you save in terms of maintenance.

You can store inert or mild products in these tanks, which range in size from 1,000 to 5,000 gallons. Syrups, juices and edible oils are typical of the products which are kept completely free from contamination by the smooth, nonadhering glassed surfaces.

Easy to clean

Cleaning costs are negligible, because you can rinse these tanks clean in a few short minutes.

Initial cost of all glassed steel storage tanks is low. For UTILITANKS, it is less than $1 per gallon in the 1,000-gal. size, ranging down to 50c per gallon in the larger sizes.

CHEMSTOR* horizontal storage tanks handle corrosive acids up to 15,000 gal., 125° F.

With the extra corrosion resistance of No. 28T glass on the inside, a CHEMSTOR tank will store your acid product without any contamination of the product or deterioration of the tank.

Available in standard sizes up to 15,000 gallons, these tanks may save you considerable money in maintenance—as well as help you produce a purer food item.

Cost is low—less than $1 per gallon in all but smallest sizes.

Also stores mild products up to 35,000 gallons

The same style of CHEMSTOR tank as described above is also available to you in larger capacities—up to 35,000 gallons—for use in storing mild or neutral products. These tanks use the same mildly resistant glass as the UTILITANK, and cost as little as 25c a gallon.

*Trademark

THE PFAUDLER CO., Dept. FT-4, Rochester 3, N. Y.

Low-cost storage *is* important to me! How big are these tanks? What fittings have they? Are there other money-saving advantages?

☐ Send me Bulletin 916 on UTILITANKS.

☐ Send me Bulletin 918 on CHEMSTOR tanks.

Name_____

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Company_____

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City_____ Zone_____ State_____

THE PFAUDLER CO., ROCHESTER 3, N. Y.

Just Out! NEW REVISED
FOURTH EDITION OF

EXPERIMENTAL COOKERY

From the Chemical and Physical Standpoint

With a Laboratory Outline

By BELLE LOWE, Iowa State College

This book has undergone considerable rewriting and reorganizing to bring you abreast of recent research results in this field. Among the important additions are a new chapter on food acceptability, recent information on the effects of storage and freezing, and many new illustrations. The book serves you in three ways:

Gives the chemical and physical bases of food preparation, particularly those of colloid chemistry.

Provides a reference book on cookery for teachers in the food field and for women in charge of commercial food laboratories.

Offers an introduction to the literature on food preparation.

1955. 574 pages. Illustrated. $7.50.

AGRICULTURAL PROCESS ENGINEERING

By S. M. HENDERSON and R. L. PERRY, both of the Univ. of California, Davis and Los Angeles, respectively.

Describes the engineering elements of agricultural processing which can increase the yield of raw farm commodities. Unit operations discussed include such processes as cleaning and sorting, air conditioning, mixing, drying and dehydration, refrigeration, and many others. 1955. 402 pages. Illus. $8.50.

STARCH AND ITS DERIVATIVES, by J. A. RADLEY, Third Edition, in two volumes. This authoritative survey has been revised, greatly expanded and brought completely up to date, with latest technology and chemistry. VOL. I, 1954. 510 pages. Illus. $10.00. VOL. II, 1954. 465 pages. Illus. $10.00.

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FOOD INDUSTRY TOPICS

(Continued from page 36)

tomer, tell the story, and close the sale in less than 90 seconds. Mr. Oppenheimer presents the following criteria as a guide in judging the correctness of package design: (1) Is the package distinctive? (2) Will the customer recognize the brand identification? (3) Does it have taste appeal? (4) Does it have the right colors? (5) Can the customer identify the product immediately? (6) Is the design simple? (7) Does the design suit the type of product? (8) Is the package designed to appeal to all buyers?

. . . *things new under the sun*

Effective, controlled, economical liquid and gas cooling in chemical processes is offered in the 30 million Btu. Niagara Aero Heat Exchanger. The unit is reported to give a constant balance of heat removal with heat input load, assuring accurate temperature control and modulated action responsive to heat load variation. Over-cooling under "no load" conditions is prevented. Write for Bulletin 124 to Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.

◆ ◆ ◆

A new lemon product called "Raspatura Limone" has been developed by Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., for general distribution. A carefully dried, finely grated lemon rind, the product will serve effectively to impart the texture, color, and flavor of fresh lemon rind where such a quality is indicated, and is particularly applicable to pie fillers and bakery items. Available in 2 forms—basic, and with 5% lemon oil.

A new straight-line, heavily constructed machine for filling semi-liquid and semi-solid products into as many as 300 glass, plastic, and metal containers a minute has been developed by the Filler Machine Co., Inc., Philmont Club Station, Pa. New air-operated valves cut off instantaneously regardless of the cycle speed, and greater accuracy of fill is provided since valves themselves are completely air-free. Standard equipment is a no-container, no-fill device preventing operation of the machine and loss of product when containers are not at the filling station. Model SL-55 can be constructed to handle from ½-ounce to 32-ounce containers, and fills jellies, preserves, mayonnaise salad dressing, cheese, cosmetics, pharmaceuticals, petroleum, and chemical products. Available in 4, 6, 8, 10, and 12 line fillers.

◆ ◆ ◆

A new type chart paper with special properties which improve legibility of instrument records has been announced by The Foxboro Co., Foxboro, Mass., industrial equipment manufacturer. Humitex circular and strip charts are printed under controlled hu-

(Continued on page 40)

If your customers gave your products a "bug count"

These Petrie dishes give a graphic demonstration of the high degree of spore and yeast removal that can be achieved with Celite filtration.

CELITE FILTRATION removes spores and yeast plus all suspended impurities

How can you be sure that your products are at their very best when they go into the laboratory of an important customer or prospect? One good way is to use the most thorough method of clarification available. That's Celite* diatomite filtration which gives you a filter cake hundreds of times finer than the finest wire mesh. It not only removes suspended impurities, but polishes filtrates to a brilliant sparkling clarity.

Celite is as economical as it is thorough. Only small amounts are required to keep the filter cake open. Fastest flow rates are obtained from the 2,500,000 filter channels in every square inch. And Celite can be used with almost any filter. Automatic operation eliminates the need for costly skilled labor.

Celite is being used successfully today for filtering sugar, beer, syrups, jellies, cooking oils and fats and many other products which at some stage are in a liquid state. Perhaps it offers advantages for your processes too. Write for full facts today.

For further information on Celite filtration for your products write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, address 565 Lakeshore Rd. E., Port Credit, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products

Johns-Manville CELITE FILTER AIDS

Today's Biggest Value

IN BACTERICIDES

KLENZADE X-4
SODIUM HYPOCHLORITE SOLUTION

- New and improved — nearly 40% more bactericidal power at no increase in price.
- Sodium Hypochlorite content increased from 4.62% to 6.4%.
- Saves money — goes one-third again as far.
- Lower pH, kinder to hands — use dilutions are non-injurious to equipment.
- Leaves no film, sediment, or deposits — rinses clear and free — easily diluted — always ready for use.
- One of America's most popular and widely used safe bactericides for dairy farms and plants.

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Branch Offices and Warehouses Throughout America
BELOIT WISCONSIN

FOR SANITIZING
FARM BULK TANKS
TANK TRUCKS
MILK CANS
VATS

KLENZADE FOG SANITIZER

FOOD INDUSTRY TOPICS

(Continued from page 38)

midity conditions on a white sulphite sheet, meeting rigid standards of uniformity and stability. Special sizing agents permit sharp, distinct recording without "feathering." Circular charts are printed and center-punched in the same operation, holding eccentricity tolerance of less than .002" between hub hole and scale circles. By an exclusive process, the printing plates are produced to tolerances of .00025". Sample circular chart sent on request.

◆ ◆ ◆

Electrical weighing with automatic control of flowing powdered materials in hopper carts is the first application of a **new floor-level platform scale** announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. These new scales of 500-pound capacity can be set in a pit 10½ inches square and less than 12 inches deep. A variety of instrumentation can be used with the scale, including indicators, recorders, and control equipment.

◆ ◆ ◆

A new bacterial development for sluggish septic tanks and cesspools was announced by The FX-Lab Co., 4 Hill St., Newark 2, N. J. The first of its kind in the sanitation field, Formula FX-11 employs heavy concentrations of microorganisms in liquid form, designed to quickly digest sludge barriers that obstruct the toilet flow of organic waste to household disposal systems. The accelerated bacterial action clears pipes, baffles, and cesspool sidewalls, and gradually liquefies undigested particles clogging the drainfield soil pores. Formula FX-11 is absolutely safe to handle, noncorrosive, and not harmful to pipes, septic tank, cesspool, or the necessary bacteria within. One quart is used for each 500 gallons capacity. It is applied simply by pouring into the toilet bowl and flushing. Available at list price of $4.98 per quart, prepaid.

◆ ◆ ◆

Household ammonia now is being marketed in metal cans. The Sunlight Chemical Corporation of Phillipsdale, R. I., has ordered a volume of American Can Company's tinless, non-drip "metal bottles" for distribution of its "Sunlight Brand Super Ammonia" in the East. The 22-ounce tinless can with the screw-top plastic cap and aluminum nozzle is similar to the non-drip can developed by Canco for liquid detergents now being used for Lux and White King. The Sunlight container has around-the-can lithography and a cemented side seam. It was pointed out that while the cost of Canco's "metal bottle" is slightly higher than a glass container, there is a considerable savings in shipping due to its light weight. From a merchandising viewpoint, it was felt that retail stores would readily accept the new ammonia can because it is compact, durable, and may even be dropped without fear of breakage.

◆ ◆ ◆

Introduction of **a new machinery mount,** the Barry Spring Mount for isolating low speeds and high impact applications, was announced by the Barry Corp., Watertown, Mass. Spring Mounts are designed for use where high absorption of vibration is necessary or where soft floors make control of vibration fre-

(Continued on page 42)

Merck Vitamin A

offers distinctive advantages in

Fortifying Margarine.....

Purity of MERCK VITAMIN A *is guaranteed by more than 100 quality-control tests applied to intermediates and the finished product.*

Margarine fortified with MERCK VITAMIN A ACETATE is free from off-odors or tastes. Continuous supplies of light-colored, stable Merck Vitamin A are assured by large plant capacity.

MERCK VITAMIN A ACETATE in vegetable oil is offered in batch size or bulk containers in a range of potencies. Our experience of two decades in the manufacture of vitamins is available to help you in the application of Vitamin A to your processes.

Other Merck Products for the Food Industry:

ASCORBIC ACID	THIAMINE	TARTARIC ACID
CITRIC ACID	SODIUM CITRATE	SODIUM BENZOATE
RIBOFLAVIN	NIACIN	VITAMIN MIXTURES

Research and Production for the Nation's Health

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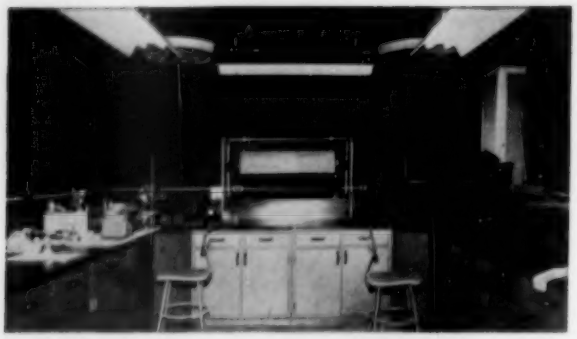


You Can Have DRY Air with EXACT Moisture Control

for your comfort, for your process, for testing machines or materials at any time of the year

Niagara Air Conditioning provides you with any temperature and relative humidity you need, held constant or varied at will. Using "Hygrol" absorbent, you save the refrigeration commonly used to condense moisture and make reheat unnecessary in most cases. It gives large capacity with compact, easily-maintained equipment.

This Niagara Air Conditioning Method dries air directly and measurably, using a moisture-absorbing liquid spray. Humidity control is a separate function from heating or cooling.

This gives you precise control over your air conditions with thermostats alone; no moisture-sensitive devices are needed. You have simpler, more trustworthy, less expensive control instrumentation. Niagara precise-control air conditioning installations have the best record for reliability.

Write for information on the application to your problem. Ask for descriptive Bulletins #112 and #121. Address Dept. FT

NIAGARA BLOWER COMPANY

405 Lexington Ave. New York 17, N. Y.

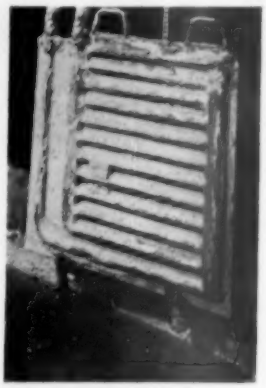
District Engineers in Principal Cities of U. S. and Canada

FOOD INDUSTRY TOPICS

(Continued from page 40)

quencies difficult. Available in 5 sizes, with 1, 2, 4, 6, or 9 springs, the mounts depending on size have an effective load range of from 250 to 6700 pounds per mount. Since there is no need to bolt or shim when machines are mounted on Spring mounts, machines can be installed and leveled in minutes.

◆ ◆ ◆



A heat transfer unit introduced about 5 years ago by Platecoil Division of Tranter Mfg., Inc., Lansing 4, Mich., has proved in practice to eliminate much fouling of pipe coils in industrial process heating and subsequent downtime and maintenance costs. The electro-polished stainless steel 22" x 23" Platecoil shown has heated a 110-gallon phosphotizing tank, in daily use for over a year, without downtime. Any deposit that builds up on the coil during operation is "shocked off" when the steam pressure is dropped in the coil.

◆ ◆ ◆

A high-pressure liquid level control electrode that will withstand pressures up to 4000 psi and temperatures up to 800° C., is announced by the Auburn Spark Plug Co., Auburn, N. Y. All metal parts of the new WCC series of electrodes are manufactured of non-magnetic stainless steel. Because these electrodes utilize an aluminum oxide insulator of better than 95% purity with a 200,000 psi compressive strength, they are expected to replace all old-style mica-insulated liquid level control electrodes now in use. The new series WCC electrodes are equipped with connecting nuts for attaching probes of any desired length or shape. Auburn manufactures the WCC series to standard sizes or individual specifications.

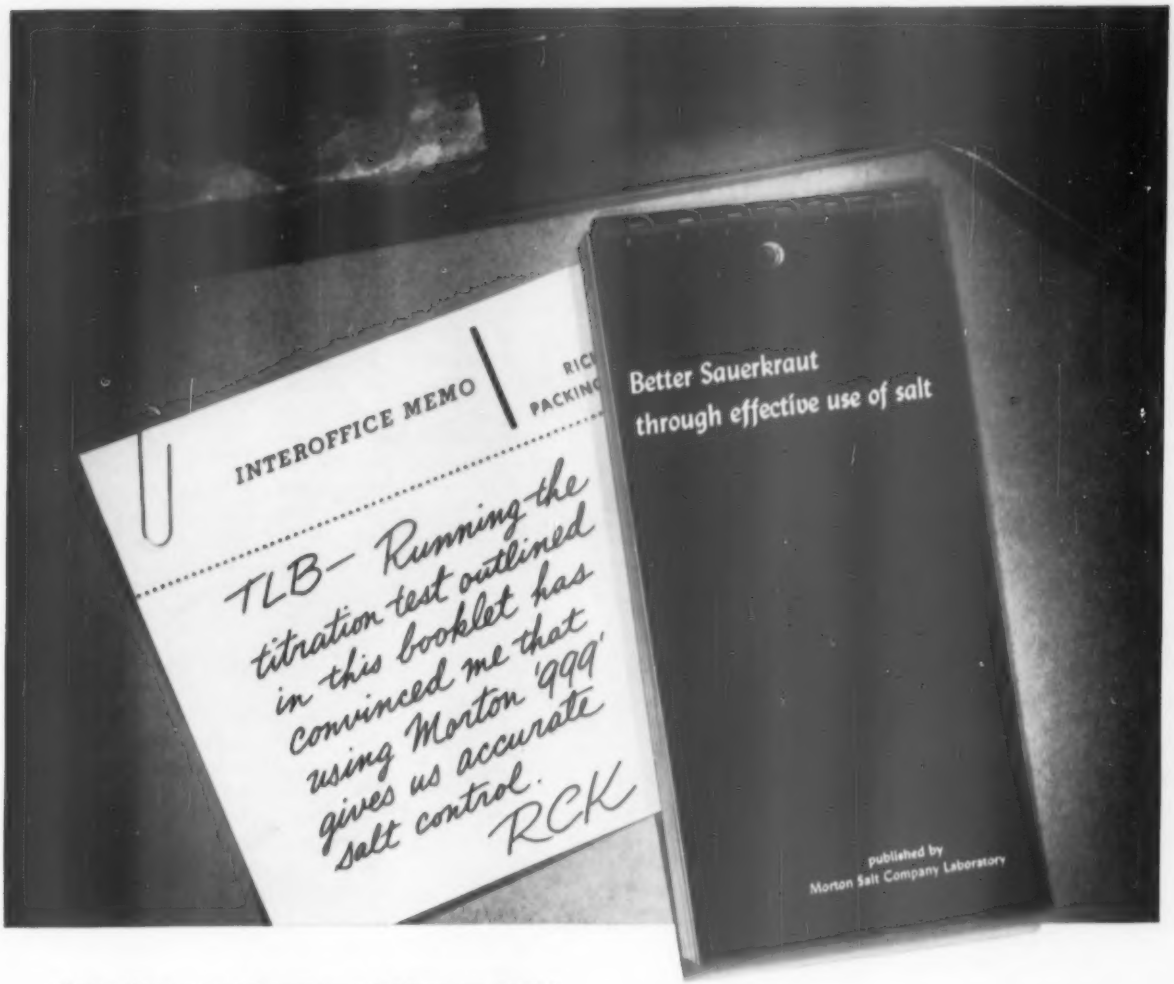
◆ ◆ ◆

Claimed to be superior to stainless steel in many applications, a **new form of a wartime substitute product** promises to greatly simplify cleaning of containers and equipment used in processing foods and beverages. Introduced as non-plasticized polyvinylchloride (rigid PVC), the surface is so smooth that special cleansers now may not be necessary. The product is rust-proof, rather than rust-resistant as is stainless steel. It is half the cost and weight of stainless steel of comparable strength, according to the processor, Stokes Molded Products Division of The Electric Storage Battery Co., Taylor and Webster Sts., Trenton 4, N. J.

◆ ◆ ◆

The Roy E. Roth Co., 2420 Fourth Ave., Rock Island, Ill., has put into production a **new line of regenerative turbine pumps** designed for boiler feed service with boilers up to 1000 h.p. and operating at pressures up to 300 psi. These pumps are 2-stage regenerative turbine pumps and contain such special

(Continued on page 44)


INTEROFFICE MEMO
TLB— Running the titration test outlined in this booklet has convinced me that using Morton '999' gives us accurate salt control.
RCK
Better Sauerkraut
through effective use of salt
published by
Morton Salt Company Laboratory

Sauerkraut packers need Morton '999' Salt to prevent quality variations. So do makers and processors of candy . . . beer . . . canned foods . . . cereals . . . pasta products . . . seasonings . . . meat . . . malted milk . . . mayonnaise . . . margarine . . . olives.

MORTON '999' SALT insures uniform quality in processed foods for two reasons. It's guaranteed to contain more than 99.9% pure sodium chloride—*always!* The 0.1% (or less) is a neutral inert sodium salt—never bitter calcium or magnesium compounds.

Vacuum pan evaporation assures that this salt will be clean . . . free-flowing . . . evenly soluble. It has a constant weight per volume ratio . . . won't pack down.

Mail coupon for further details today! And, if you are a sauerkraut packer, ask for the free waterproof booklet with titration color cards and complete information on how to test kraut for salt content.

MORTON '999'

the salt that carries its own guarantee

MORTON SALT COMPANY
Industrial Division, Dept. FT-4
120 So. LaSalle St., Chicago 3, Illinois

☐ **I should like to have a Morton representative call and give me—without obligation—more information on Morton '999' Salt and methods of using it in my product.**

☐ **Please send your free booklet, "Better Sauerkraut through effective use of salt."**

Name_____

Title_____

Company_____

Address_____

City_____ State_____

Seacret Number 6

did you know?

. . . that SeaKem "Colloids Out of the Sea"* add viscosity to many solutions at very low concentrations. In addition, solutions of SeaKem Colloids are ionized, resulting in a negatively charged polymer having interesting interactions with proteins and other large molecules. This characteristic sometimes makes them particularly useful at extremely low cost in products containing milk solids.

*SeaKem is the registered trademark for the standardized hydrocolloids obtained from Irish Moss by the Seaplant Chemical Corporation. Extracted and refined by rigidly controlled processes which insure dependable uniformity and purity, SeaKem Colloids are light amber to colorless, free-flowing powders. Available in a variety of types suitable for a wide range of stabilizing functions, SeaKem Irish Moss Extractives have won acceptance with leading food manufacturers on the basis of their unique contributions to product improvement problems.

Have you a problem? If so,
Write today for more information.

Seaplant CHEMICAL CORPORATION
63 David Street, New Bedford, Mass.

FOOD INDUSTRY TOPICS

(Continued from page 42)

features as low pressure stuffing boxes and balanced shaft loading. Models available in standard fitted, bronze fitted, all iron, and all bronze construction, all with stainless steel shaft. Write for Bulletin No. 107.

◆ ◆ ◆

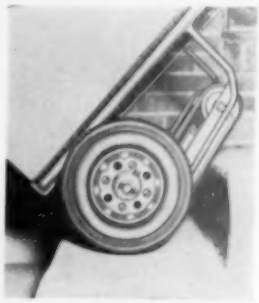
Visibility of over 1500 feet has been proved for this **new flashing electric road flare** being introduced to haulers of baked goods and other foodstuffs by the automotive parts division of Buffalo Weaving and Belting Co., Alliance, O. Since the flare is electric, it is odorless and creates no fire hazards. Tests show it meets or exceeds all 1954 SAE Specifications for electrical emergency lanterns, passing all tests for vibration, moisture, dust, corrosion, reliability, and visibility, as required by ICC regulations. An added advantage of visibility even in heavy snows is afforded by Flash-Flare's 20" height.

◆ ◆ ◆

A new line of rotary type pumps, combining the basic self-priming, no stuffing box, no shaft seal features of the Vanton Flex-i-liner pump with a design that permanently protects all bearings from fumes or chemical attack has been announced by Vanton Pump & Equipment Corp. (Division of Cooper Alloy Corp.), Hillside, N. J. Designated the XB series, the pumps are available in capacities from fractional to 5 g.p.m., with 0-50 psi discharge pressures.

◆ ◆ ◆

A new line of trucks, equipped with non-mar and easier operating stair glides, is offered by Nutting Truck and Caster Co., 1201 W. Division St., Faribault, Minn. Their glide assemblies are equipped with rubberized fabric V-belts which cannot damage in any manner stairs having finished surfaces; for less effort going up or down, the glide assemblies are positioned to permit a smooth movement parallel to slope of curbs or stairs, rather than the intermittent raising and lowering of the load as with conventional glides. Circular on request.



◆ ◆ ◆

A series of rapid identification of livestock feed ingredients through their fluorescence under ultra violet light has been developed by the Assn. of Feed Microscopists. Both short and long wave ultra violet lamps, manufactured by Ultra-Violet Products, Inc., 145 Pasadena Ave., So. Pasadena, Calif., were used with good results. The long wave length was of particular use in identifying materials used in blending meat and bone scraps as well as indicating presence of unwanted materials such as dried blood, hair, and hoof. The short wave length lamp was helpful in identifying certain minerals. Experiments with stains and dyes in conjunction with the lamps also proved successful in product identification. A quality check on oil seed products was also found possible through so-called black light.

◆ ◆ ◆

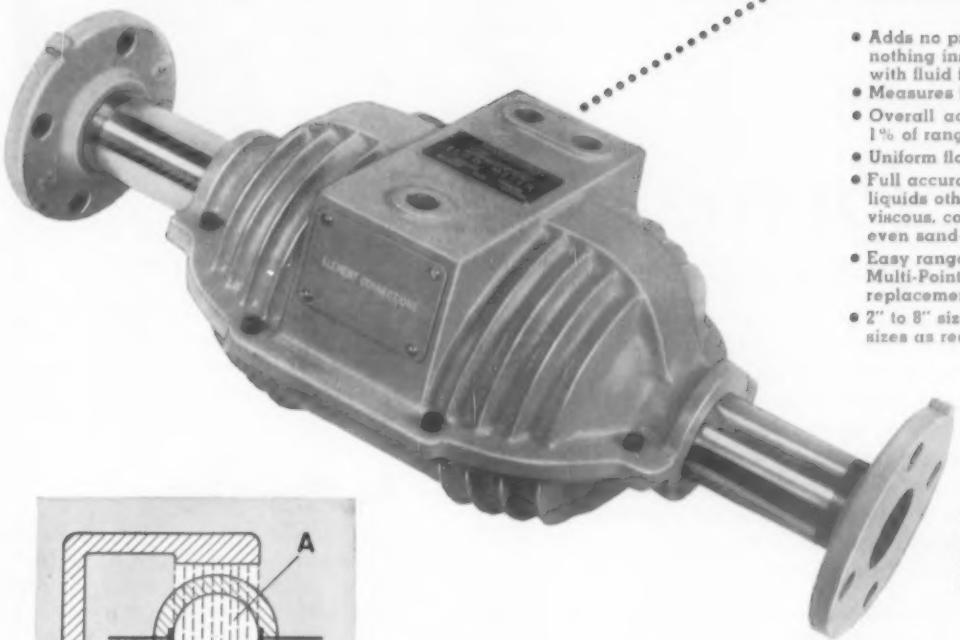
American Floor Products Co., 4922 Wisconsin Ave., N. W., Washington 16, D. C., offers a **new industrial and commercial floor matting** designed to reduce employee fatigue and injury. The product, Neo-Sponge comfort mat, is made through a special patented process of blowing millions of inert nitrogen bubbles into Du Pont's Neoprene. Its outstanding properties are: permanent resilience, high electrical resistance (61,000 volts before puncture), and an almost impervious resistance to acid, oil, grease, and heat. The mat is reversible and reportedly will outwear any similar rubber product. Unlike rubber, it will not absorb any liquid or vapor. Available in 2 thicknesses—¼" and ⅜" and in standard sizes up to 36" wide x 10" long. Larger sizes supplied upon request.

◆ ◆ ◆

A new range of sizes and capacities from 1 g.p.m. to 10,000 g.p.m. in the unique "American" Homomix continuous pipeline chemical mixer is announced by

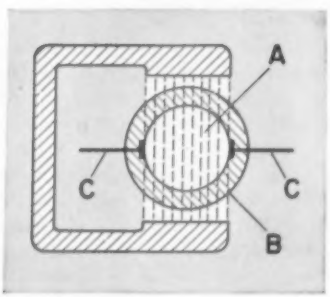
(Continued on page 46)

NEW! a flow meter with no flow restrictions!



- Adds no pressure drop — nothing inside pipe to interfere with fluid flow.
- Measures fluid velocity directly.
- Overall accuracy better than 1% of range over entire scale.
- Uniform flow scale.
- Full accuracy sustained even on liquids other meters can't handle: viscous, corrosive, or pulpy — even sand-water slurries.
- Easy range change — either by Multi-Point Switch or range coil replacement, as preferred.
- 2" to 8" sizes standard — larger sizes as required.

FOXBORO MAGNETIC FLOW METER



SIMPLE, TROUBLEFREE, OPERATION

The Foxboro Magnetic Flow Meter operates on the same principle as a power generator. A magnetic field (A) is maintained through a standard pipe section (B) of stainless steel or other non-magnetic material. This pipe section is lined with Kel-F® or other insulating material. Liquid passing through pipe acts as moving conductor, generating an electric voltage which varies in proportion to liquid's average velocity. Flush electrodes (C) in pipe wall "pick up" this voltage which is recorded in desired flow units by Dynalog Electronic Recorder or Controller.

This premium-performance meter measures *magnetically* the flow rate of virtually any liquid except hydrocarbons. It completely ignores such common metering headaches as turbulence, suspended solids, and variations in conductivity, density, and viscosity. It even measures reversing flows.

Installation is simple. The magnetic spool piece connects into the line like any equivalent length of pipe — no seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Electronic Flow Recorder.

Maintenance is practically eliminated. There are no pressure taps to become plugged or frozen, no working parts to foul.

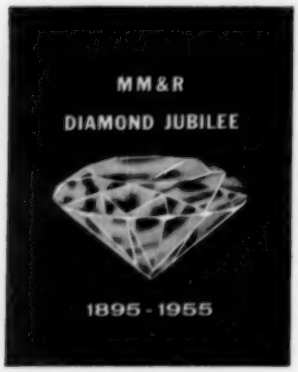
Foxboro Magnetic Flow Meters are already in use on such widely different liquids as beer, sand-and-water, rosin size, rock-and-acid slurry, viscose, and highly corrosive liquid detergent. Find out how this precise, troublefree flow meter can help *your* processing. Write for complete details.

THE FOXBORO COMPANY, 354 NORFOLK STREET, FOXBORO, MASS., U. S. A.

FOXBORO
REG. U. S. PAT. OFF.

Foremost in FLOW METERING

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND



Partners in Progress

The growth and development of *MM&R* span the six most momentous decades in the business and industrial life of America. During this period, the swift pace of discovery and invention remade the American way of life. Successfully meeting the challenging problems of expanding industries, *MM&R* advanced to a position of leadership in the world's essential oil markets.

Today, equipped with the most modern facilities for research and production, splendidly staffed, and sustained by long experience and vast international resources, *MM&R* is preeminently qualified to serve its customers in all parts of the world.

Customers made our business—customers will keep us in business. Their reliance on the resourcefulness and ingenuity of *MM&R* has been an important factor in the development and manufacture of many new fragrances and flavors to give greater sales appeal to their products. Such confidence and support, for which we are most grateful, made possible our Diamond Jubilee.

Magnus Mabee & Reynard, Inc. and its *customers* are indeed — *partners in progress.*

MAGNUS, MABEE & REYNARD, INC.

One of the World's Greatest Suppliers of Essential Oils, Flavors and Basic Perfume Materials.

16 DESBROSSES STREET, NEW YORK 13, NEW YORK
221 NORTH LASALLE STREET, CHICAGO 1, ILLINOIS

FOOD INDUSTRY TOPICS

(Continued from page 44)

The American Well Works, Aurora, Ill. The units work right in the pipeline—mix instantaneously at point of entry, provide violent, uniform, and complete

◆ ◆ ◆

A new, compact device that automatically prints a number, date, or time on Brown strip charts and similar recorder charts at any instant when a voltage is applied to the device during process, test, and control work has been developed by Royson Engineering, Hatboro, Pa. The unit, called the "Identichart," makes it easy for users to identify individual sections of recording charts in relation to particular conditions taking place at a remote point. The unit mounts on the outside of the door of the recorder regardless of type and does not interfere with or obscure the recording procedure. Made for 28 volts D.C. operation, but can be adapted to other electrical requirements. Supplied in kit form and easily assembled and installed.

blending on one or more chemicals (liquid, gas, or slurry) continuously or intermittently without use of a mixing tank, permit a wide range in percentage of additives to base fluid, and assure accurate mixing control in chemical, beverage, sugar, fuel, pigment,

In Memoriam

James Courtenay Hening, Associate Professor of Chemistry in the Department of Food Science and Technology at the Experiment Station, Geneva, N. Y., died Thursday (February 17th), following an extended illness. He was 63 years of age.

Professor Hening organized and directed the taste panels utilized extensively at the Experiment Station in evaluating the result of the researches of all Station departments. He published numerous technical papers on the subject and was called upon to discuss the technic before other institutions. Professor Hening joined the staff of the Experiment Station in 1923 as assistant in research in the Dairy Department, since transferred to the College of Agriculture at Ithaca. In 1943, Professor Hening was granted leave of absence to serve as food technologist of the Research and Development Laboratory of the Quartermaster Corps, U. S. Army, in Chicago. He served in this capacity until 1946, conducting researches on the improvement of field rations for the Armed Services.

Upon his return to the Experiment Station he was appointed Assistant Professor of Chemistry in the Department of Food Science and Technology and in 1952 was promoted to Associate Professor. Born in Stillwater, Minn., May 11, 1891, Professor Hening received the B.S. and M.S. degrees from the University of Minnesota and also did graduate work at the University of Wisconsin. He married Rachel Evans in 1923. His wife and a brother, Dr. Robert Hening of Baltimore, Md., are the only survivors.

and many other product processes. The new, smaller sizes now make the Homomix readily applicable to all requirements of the chemical and other process industries—for blending, absorbing, contacting, washing, chlorinating, etc. Write for Bulletin No. 300.

. . . *the literary corner*

Many a businessman stands in awe of the engineering profession's accomplishments in today's atomic age, but is a little impatient with the growth of "engineeringese" in our everyday language. Words like "sinusoidal," "reproducibility," "feedback," "optimalization" are bandied about these days by engineering-trained executives as though common terms, leaving the non-technical folk nonplussed. To try and clear up some of the confusion, the Philadelphia-based Industrial Division of Minneapolis-Honeywell packaged the technical terms most broadly used in a modest booklet complete with amazingly clear, laymanlike definitions. This little "Automation Dictionary" covers some 87 words and phrases, all of which had their origin with the engineers but are now creeping into the lexicon of today's modern businessman. For a copy write the firm at Wayne and Windrim Aves., Philadelphia, Pa.

◆ ◆ ◆

New developments in the construction of Pfaudler dairy tanks are announced in a 12-page catalogue published by The Pfaudler Co., Rochester 3, N. Y. Cross section drawings show a vertical agitator and an air agitation system now available in addition to the horizontal Pfaudler Stream-Flo agitator. The bulletin includes previously unpublished data about 4 different types of refrigeration systems now available. Another chart compares the storage capacity of round and rectangular tanks occupying the same floor area. The rectangular tanks store from 33⅓% to 150% more milk in the same floor space; the smaller the tank, the greater the increased storage space.

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The latest edition of the king-size catalog, January-April 1955, published by Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y., international essential oil firm, contains interesting and valuable information about essential oils, concentrated flavors, basic perfume oils, etc., used to increase the sales appeal of candy, foods, cosmetics, and other commodities in over 50 industries. Free copy available on request.

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From the January 15 issue of *Information Bulletin*, published by The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo., comes this portentous paragraph: "Students of our industrial history frequently point out that our success is based on continuous development and expansion. It

ACCESSORY NUTRIENT FACTORS

For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77

(Dehydrated) a Complete Culture Medium

FORMULA		
Ingredients—when rehydrated on basis of 45 grams per liter of medium.	Orange juice serum solids	12.6g*
	Agar (dry basis)	15g
	Peptone	10g
	Yeast hydrolysate	3g
	Reducing sugars, total	8g
	Sucrose, total	0g
	Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit pickling, food, bottling and fermentation industries.

Available in 1 lb. bottles through your laboratory supply house.

Sunkist Growers

PRODUCTS DEPARTMENT

Exchange

PHARMACEUTICAL SALES • ONTARIO, CALIFORNIA

is expected that our U. S. A. national product will soon reach the annual level of 500 billion dollars and that our rate of acceleration will carry us to a second 500 billion within the lives of a single generation. Those predictions are based on assumptions—a major one being the continuation of advanced research, advanced planning, and strong, intelligent leadership. Certainly, the future of refrigeration looms large—provided we keep pace."

◆ ◆ ◆

Methods of speeding up tomato sorting with only half the manpower formerly required are detailed in a new 4-page folder released by R. G. White Mfg. Corp., 101-18 97th Ave., Ozone Park 16, N. Y. Illustrated with production photographs and engineering drawings, the folder presents the case history of a tomato packer whose problem was solved by installation of a new, highly mechanized tomato sorting line.

◆ ◆ ◆

Technical Charts, Inc., 189 Van Rensselaer St., Buffalo 10, N. Y., offers a new 12-page catalog outlining their services in producing recording charts for standard and special instruments. It includes samples of both dial and roll type charts. The method of production of over 8000 different standard charts is outlined. Technical information is given on requirements for special charts.

◆ ◆ ◆

A practical, easy-to-use formula for estimating the water costs that occur when the discharge water from an air conditioning or refrigeration system is dumped down the drain is a feature of Catalog No. 700, new 8-page bulletin of Acme Industries, Inc., Jackson, Mich. A second formula shows operating costs with an Acme Cooling Tower conserving up to 97% of the water. The catalog illustrates and explains the construction and operation of Acme towers in the capacity range of 15 through 100 tons.

◆ ◆ ◆

A general tubing catalog which condenses into 8 pages the pertinent information needed for selection and application of 46 principal analyses of tubing, has been published by Superior Tube Co., 1697 Germantown Pike, Norristown, Pa. Designated Bulletin 40, the catalog groups the 46 analyses into 5 classifications: (1) stainless steel, (2) nickel and nickel alloys, (3) carbon and alloy steels, (4) beryllium copper, and (5) titanium. A short summary of the principal properties of each analysis and its normal production limits is given. The properties of 6 glass-sealing alloys also are given.

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Arkell & Smiths, manufacturers of multiwall and specialty bags, is offering a valuable 10-page bulletin on "Palletizing Filled Multiwall Bags." Based on laboratory tests and field checks, and complete with detailed drawings, the bulletin contains useful ideas and suggestions to facilitate handling, shipping, and adapting bags now being used to fit a given pallet. Address: Arkell & Smiths, Packaging Dept., Canajoharie, N. Y.

. . . meeting hall and conference room

The Committee on Vacuum Techniques, Inc., invites the presentation of papers at the Second Symposium on Vacuum Technology to be held at Mellon Institute, Pittsburgh 13, Pa., June 7-9, 1955. The program will deal with equipment, instrumentation, fundamental developments in vacuum technology, standards, nomenclature, methods and techniques, and vacuum systems applications and processes. Those interested in presenting a paper should contact Mr. Rudy Koehler, Committee on Vacuum Techniques, Inc., Box 1282, Boston 9, Mass.

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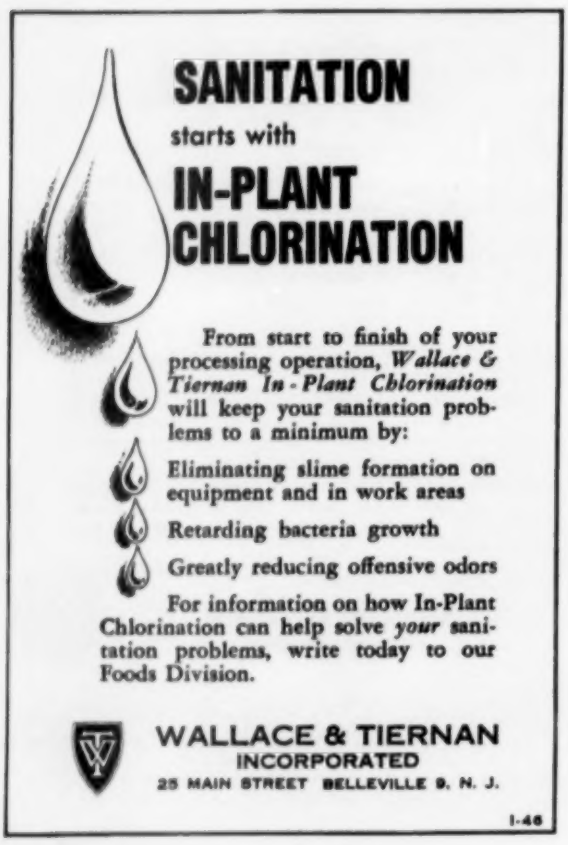
Remember the annual meeting of the American Oil Chemists' Society, to be held April 18-20 at the Roosevelt Hotel in New Orleans, La.

◆ ◆ ◆

Most chemicals added to foods are fundamentally a component of some natural food and contribute to improved nutrition, better health, increased longevity, and the gradual disappearance of dietary diseases, it was brought out at a recent joint meeting on chemicals in foods and feeds, sponsored by the Commercial Chemical Development Assn. and the Chemical Market Research Assn., Edgewater Beach Hotel, Chicago. Three symposia—on "Chemicals and the Feed Industry," "Chemicals and the Food Industry," and "Introducing New Products to the Food and Feed Industries," highlighted the meetings. At the last-named symposium, the many considerations — legal,

(Continued on page 51)


SANITATION
starts with
IN-PLANT
CHLORINATION
From start to finish of your processing operation, Wallace & Tiernan In-Plant Chlorination will keep your sanitation problems to a minimum by:
Eliminating slime formation on equipment and in work areas
Retarding bacteria growth
Greatly reducing offensive odors
For information on how In-Plant Chlorination can help solve your sanitation problems, write today to our Foods Division.
WALLACE & TIERNAN
INCORPORATED
25 MAIN STREET BELLEVILLE 9, N. J.
1-46

Felton's complete line of FELCOFIX powdered flavors offers you the best answer to the problem of permanently flavoring all kinds of dry, semi-dry or powdered products . . . completely eliminating that old shelf-life bugaboo!

These outstanding flavors are supplied as dry, perfectly homogeneous powders that remain fresh, true and delicious even when used in mixtures containing acids, sugars and other reactive ingredients.

Their concentration and lasting power are equally amazing, and result in economies that are important to your profits.

It will pay you to try our FELCOFIX flavors without delay!

Write now for Samples of these amazing new **FELCOFIX** locked-in **FLAVORS**

FLAVORS • ESSENTIAL OILS • AROMATICS

FELTON CHEMICAL COMPANY, INC.
599 Johnson Ave., Brooklyn 37, N. Y.

*FELCOFIX is a trade mark of Felton Chemical Co., Inc.

PLANTS: BROOKLYN, N. Y. • LOS ANGELES, CAL. • MONTREAL, QUE. • VERSAILLES (S & O) FRANCE
SALES OFFICES: ATLANTA • BOSTON • CHICAGO • CLEVELAND • PHILADELPHIA • ST. LOUIS • TORONTO

Diamond Crystal Alberger Salt is

America's largest-selling High-Grade* salt

because...

the exclusive Diamond Crystal Alberger System produces:

Purity—99.95% Sodium Chloride.

Uniformity—maximum purity variation ±0.01% . . . screened to a standard for each food product.

Cleanliness—lowest insolubles of any commercial grade of salt.

Low heavy metals—less than 1.5 part per million of pro-oxidants copper or iron.

**The premium grade salt used by food processors.*

FOOD TECHNOLOGIST AT YOUR SERVICE

For free consultation on choice and application of the right salt for your food products—call, wire or write:

Technical Service Dept. B
Diamond Crystal Salt Co.
St. Clair, Michigan
Phone—296

FOOD INDUSTRY TOPICS

(Continued from page 48)

medical, and marketing—involved in introducing new products to the food and feed industries were discussed.

. . . building up and branching out

Foster D. Snell, Inc., New York chemical and engineering consultants, announce purchase of the Crippen and Erlich Laboratories, Inc., 1138 E. North Ave., Baltimore 2, Md. Mr. Raymond C. Crippen, founder, will continue as secretary-treasurer of the corporation and director of the laboratory which will operate for the present as a wholly owned Snell subsidiary. The other officers will be Dr. Foster D. Snell, president, and Dr. Chester A. Snell, vice president.

◆ ◆ ◆

Blaw-Knox Company's Process Equipment Department, formerly at Pittsburgh, Pa., is being integrated into an enlarged and modernized Buflovak Equipment Division at Buffalo, N. Y., as one of the first phases of the firm's $15,000,000 modernization program. The new facilities will enable the Division to meet the needs of the process industries with a broad line of equipment, including high pressure autoclaves, gas cleaners, quick-opening doors for pressure vessels, dryers, evaporators, processing kettles, pilot test plants for research and development, and many other products in addition to equipment built to customer's specifications.

◆ ◆ ◆

Food Machinery and Chemical Corporation has acquired the food canning machinery business of Chain Belt Co., Milwaukee, Wis. Included in the transaction are patent rights, trade marks, tools, drawings, and parts and finished inventory covering Chain Belt's Micro Film Deaerator, Roto-Brush Can Cleaner and Drier, Steam Blancher, Agi-Tort Sterilizer, Thermo-Roto Heater, Cooler and Can Turner, and Continuous Juice Sterilizer. The Chain Belt Vacuum Dehydrator is not included in this acquisition of products. The acquisition serves to round out the extensive lines of

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1955	
March 29-April 7	The 127th National Meeting of the American Chemical Society, Cincinnati, Ohio
April 17-20	Forty-sixth Annual Meeting of the American Oil Chemists Society, Roosevelt Hotel, New Orleans, Louisiana
April 18-21	Twenty-fourth National Packaging Exposition, American Management Association, International Amphitheater, Chicago, Illinois
May 15-19	Annual Meeting of the Association of Cereal Chemists, Chase Hotel, St. Louis, Missouri
May 22-26	International Bread Congress, Hamburg, Germany
May 23-25	Ninth National Convention, American Society for Quality Control, New York City
June 8-10	Eighth Annual Meeting, Research and Development Associates, Food and Container Institute, Inc., Chicago, Illinois (together with Radiation Sterilization of Foods Symposium, June 10, 1955).
June 12-16	Institute of Food Technologists, Deshler-Hilton Hotel, Columbus, Ohio

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

RECOMMENDATIONS FOR USING 8 FOLD

MERORY FULL AROMATIC CHERRY FRUIT FLAVORS

(PATENT PENDING)

MORELLO • BLACK CHERRY • DALMATIAN TYPE

FLAVOR PROFILE:

One gallon of 8 FOLD FULL AROMATIC CHERRY equals in flavor strength and natural fruit color to 8 gallons of juice expressed from 84 pounds of freshly picked cherries. The characteristic cherry note of the pits is derived by hydrolosis and distillation of the fruit after grinding.

FLAVOR STRENGTH:

Flavor and color of fully ripe cherries are closely correlated. Flavor strength is tested by dilution with water. Identification of fruit flavor in absence of color indicates fortification with other aromatics.

MANUFACTURING PROCESS:

Full Aromatic Cherry Fruit Flavors are made from freshly picked, federal and state inspected first grade, fully ripe cherries. The intermediate manufacture is handled in modern plants near the cherry orchards to avoid prolonged transportation, temperature changes, and exposure of fruit to air and oxidation. The fruit is washed in fresh cold drinking water, then run over an inspection belt to eliminate impurities. The cleaned cherries are rapidly processed and the most advanced production methods applied to retain completely the fragrant freshness of the volatile aroma and the full flavor of the fruit as well as to preserve the brilliant intensity of the fresh fruit color. Flavor and color are guaranteed to remain stable for any length of time.

FLAVOR COMPOUND:

MORELLO, BLACK CHERRY, and DALMATIAN 8 Fold Full Aromatic Cherry Fruit Flavor Concentrates serve as basic ingredients in compounds of Commercial Flavorings for use in Syrups, Beverages, Ice Cream, Sherbet, Fruity Ice Pop, Gelatine Dessert, Flavor-Aid Base Powders, Confectionery, Bakery Goods, and Other Food Products.

***FORMULA # 1*—BLACK CHERRY WONF**
(For syrup and carbonated beverages)

Mixture of

21 Gals. 8 Fold BLACK CHERRY MF.856
15 Gals. 8 Fold DALMATIAN TYPE MF.906
6 Gals. 4 Fold RASPBERRY MF.953
1 Gal. 2 Fold BOURBON VANILLA MF.100
*36.25 Gals. Desugared Grape Extract (Fruit Color) and 2 pounds Acid Citric
*12 Gals. Caramel—acid proof
8.75 Gals. Alcohol 95% and 6½ to 9¼ pounds Oil of Bitter Almond FFPA

100 Gals. BLACK CHERRY FRUIT FLAVOR WONF

*(Desugared Grape and Caramel can be substituted by artificial colorings and water.)

Use 2½ to 4 fl. ozs. per gallon of syrup
(add 1¼ fl. ozs. acid citric 50%)

***FORMULA # 2*—CHERRY CORDIAL FLAVOR**

Mixture of

50 Gals. 8 Fold DALMATIAN TYPE MF.906
10 Gals. 8 Fold MORELLO MF.855
4 Gals. 4 Fold RASPBERRY MF.953
1 Gal. 2 Fold BOURBON VANILLA MF. 100
4 Gals. Caramel—spirit proof
5.5 Gals. Alcohol 95% and 1.75 pounds Oil of Bitter Almond FFPA
25.5 Gals. Water or Montmorrency Cherry Juice

100 Gals. CHERRY FRUIT FLAVOR WONF (approx. 15% alcohol)

Use 3 to 5 gals. per 100 gals. of Cherry Cordial

***FORMULA # 3*—CHERRY FLAVOR-AID**
(Base Powder)

Mixture of

2.75 pounds 8 Fold BLACK CHERRY MF.856
2.25 pounds STABLE CHERRY IMITATION MF.600
95 pounds CERELOSE, pulverized

100 pounds CHERRY FLAVOR-AID TRUE FRUIT AND IMITATION

Use 12½ pounds per 100 or 300 pounds Dextrose (including acid and artificial coloring)

CHERRY FLAVOR-AID is a base powder for Soft Drinks, Sherbet, Ices, and Desserts.

FLAVOR-AID is a trade name originated by MERORY FLAVORS INC.

***FORMULA # 4*—CHERRY GELATINE DESSERT**

Mixture of

24 fl. ozs. STABLE CHERRY IMITATION MF.600
38 fl. ozs. ALCOHOL 95%
34 fl. ozs. 8 Fold BLACK CHERRY MF.856
32 fl. ozs. 8 Fold DALMATIAN TYPE MF.906

128 fl. ozs. CHERRY GELATIN DESSERT FLAVOR TRUE FRUIT AND STABLE IMITATION

Use 0.1 ml. per 3 ozs. unflavored gelatine dessert mixture

***FORMULA # 5*—LIQUID BLACK CHERRIES**

Mixture of

77 fl. ozs. 8 Fold MORELLO MF.911
32 fl. ozs. 8 Fold DALMATIAN TYPE MF.906
3 fl. ozs. Pit Flavor Special MF.163
16 fl. ozs. 4 Fold RASPBERRY MF.953

128 fl. ozs. or 1 gallon mixed with 9 gals. Sugar syrup 40-42 Baumé

10 Gals. LIQUID BLACK CHERRIES

Use ½ gal. per 5 gals. Ice Cream or Sherbet Mix, Milk, or other Dairy Products.

***FORMULA # 6*—BLACK CHERRY FRUITY ICE POP**
(Emulsion)

Disperse and Mix

4 fl. ozs. CHERRY OIL IMITATION MF.402
16 fl. ozs. PROPYLENE GLYCOL
2 w. ozs. TRAGACANTH
32 fl. ozs. Water and
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Use 1 fl. oz. per 5 gals. Mix of Cherry Fruity Ice Pop

FOOD INDUSTRY TOPICS

food preparation and processing equipment produced by FMC's Canning Machinery Division at its major plants in San Jose, Calif., and Hoopeston, Ill.

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The Paper Container Division of Continental Can Company now is able to offer a full line of ice cream containers as a result of acquisition of the [illegible]an Paper Goods Co., Kensington, Conn. The latter firm manufactured a line of single-wrapped ice cream containers, while Continental's Paper Container Division manufactured a double-wrapped line. The combination of both lines enables Continental to provide complete ice cream cup needs for the industry.

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The Kontro Co., Inc., Petersham, Mass., is the new name of the consulting and process equipment business of Mr. Arne R. Gudheim recently affiliated with Artisan Metal Products, Inc., Waltham, Mass. Laboratory facilities will be maintained at both Petersham and Waltham.

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Beckman Instruments, Inc., Fullerton, Calif., has completed the acquisition of Specialized Instruments Corp., and Spinco Service Co., both of Belmont, Calif. These companies, which will henceforth be known as the Spinco Division of Beckman Instruments, Inc., manufacture and distribute a unique line of instruments for advanced research in the chemical, biophysical, and medical fields. Typical of these is an ultracentrifuge which produces centrifugal forces of 250,000 times gravity, and makes possible the rapid determination of the molecular weight of complex molecules of biochemical nature by the sedimentation-velocity method. The Spinco Division will retain its headquarters and manufacturing facilities at the Belmont, Calif., location.

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To intensify its development of new uses and broader outlets for metal and fiber containers, American Can Company has formed a "new products" department, it was announced by Mr. Wm. C. Stolk, president. Mr. Roscoe M. Roberts, formerly general manager of the firm's closing machine department, is general manager of the new department which will coordinate a number of functions previously carried out by other departments. The company also has appointed new general managers of its manufacturing and purchasing departments. Mr. C. F. Lausten, assistant general manager of manufacture, has been named general manager of that department, succeeding Mr. G. W. Reese, elected vice president in charge of the Atlantic Division. Mr. H. R. Larsen has been made general manager of the general purchasing department. He had been assistant general manager.

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. . . *the human element*

Eight research scientists share the 1954 Glycerine Research Awards for achievements ranging from basic studies on the structure of glycerine derivatives to an improvement in the transfusion of red blood cells stored in glycerine at below-freezing temperatures, it was announced by the Glycerine Producers' Assn., New York City. First award of an honor plaque and $1000 honorarium went to **Prof. R. K. Summerbell** of Northwestern University, Evanston, Ill., and **Dr. James R. Stephens** of the American Cyanamid Co., Stamford, Conn., for their proof of the structure and configuration of a number of well-known derivatives of glycerine and some new related chemical compounds. Two teams of chemists share the second award of honor certificate and $300 stipend for establishing independently the biological asymmetry of glycerine. **Dr. R. W. Swick** and **Akira Nakao** formed one team carrying out research at the Argonne National Laboratory, Lemont, Ill. The other team was composed of **Drs. Harland G. Wood** and **Per Schambye** of Western Reserve University, Cleveland, O., and **Dr. G. Popjak,** National Institute for Medical Research, Mill Hill, London. A new, simple method of transfusing thawed red blood cell-glycerine mixtures directly into the veins was granted third award of honor certificate and $200 stipend. This development was the work of **Dr. H. A. Sloviter,** School of Medicine, University of Pennsylvania, Philadelphia.

◆ ◆ ◆

Mr. Arthur S. Harelick has joined the Dairy Products Laboratory staff of National Dairy Research Laboratories, Oakdale, N.Y., as research chemist. **Mr. John G. Lomot** has joined the same staff as analytical chemist.

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Mr. Ray L. Dunlap announces his resignation as food technologist for the J. R. Simplot Company, and will operate a custom cannery at Nampa, Idaho, under the name of Nampa Custom Cannery. IFT member Dunlap will also be in the food processing consultation field as well as connected with the distribution of Nutrilite Food Supplement. The full address is Nampa Custom Cannery, Midland Blvd. at Davis Ave., Route 5, Nampa, Idaho.

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The Board of Directors of the Minute Maid Corporation has elected **Mr. Frank Penn, Dr. Wallace R. Roy,** and **Mr. Wm. E. Speeler** as vice presidents, according to announcement by Mr. John M. Fox, president. Mr. Penn has been assigned the responsibility for production of Minute Maid frozen food packs outside the State of Florida. Dr. Roy, an IFT member, has been head of the firm's Research and Development Department since it was organized in 1950. Mr. Speeler is corporate counsel and secretary of the corporation.

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Mr. Alander F. Hogland has joined Electronic Processes Corp., Los Altos, Calif., manufacturer of high-frequency and impulse-heat sealing equipment for plastic processing in the manufacturing and packaging fields, as general manager according to an announcement by Mr. Gregory W. Blessing, president.

◆ ◆ ◆

Mr. John K. Boykin has been named resident manager at Charlotte, N. C., for National Aniline Division, Allied Chemical & Dye Corp., succeeding Mr. Julian T. Chase who has retired after 50 years of service. Mr. Boykin will be succeeded as resident manager at Atlanta by **Mr. T. M. Ferguson** who has been in charge of the firm's technical service laboratory there.

◆ ◆ ◆

Promotion of **Mr. Clifford E. Smith** to the newly created rank of research associate at the A. E. Staley Mfg. Co., Decatur, Ill., corn and

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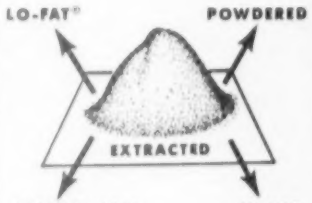

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FOOD INDUSTRY TOPICS

soybean processor, was announced by Mr. L. O. Gill, director of the company's research department. The new position offers Staley research chemists the opportunity for continuous advancement far beyond what was possible formerly.

◆ ◆ ◆

Mr. Herman Lebeson, president of Certified Products Company and a member of IFT, announces that **Mr. H. C. Needle,** also an IFT member and a veteran of 25 years experience in food technology, will be in charge of the firm's laboratory and supervisor of quality control. The company, recently moved into larger, more modern quarters for the production of its preserves and jellies, is now located at 624 W. Root St., Chicago 9, Ill.

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Mr. Jay Steiner has been appointed advertising and sales promotion manager of F. J. Stokes Machine Co., Philadelphia, Pa., Mr. A. A. Hutchings, vice president in charge of sales, has announced. Mr. Steiner was formerly assistant advertising manager.

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FOOD TECHNOLOGIST: For a position in the Research and Development Division of a large package manufacturer located in Central Ohio. Duties include work on packaging problems with customers and development work on our products. Position requires a good background in Chemistry, Bacteriology and Foods. Should have 3 to 8 years' experience, be able to meet customers and supervise employees.

If you are interested in a permanent connection which offers excellent opportunity, send complete details of experience. All replies confidential. **BOX 394,** Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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WANTED: Young BACTERIOLOGIST, degree. Some industrial exp. foods. To head up new dept. Excellent opportunity. REPLY BOX 401, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: RESEARCH Ph.D., 30-35. Young man with broad education in science and high academic record. To direct development of new products for midwest food organization. REPLY BOX 400, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

FOOD TECHNOLOGIST—Staff position with large organization in Washington, D. C., area concerned with research and development of subsistence and rations, with minor emphasis on packaging. To act as staff coordinator and planner for diversified fields — animal, dairy, fruit, baked and other food products. Substantial food development experience desired. REPLY BOX 395, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Scientist; administrator, problem-solver, trouble-shooter. Ph.D. 31. Married, now employed. Seeks position in Caribbean area — Central or South America. REPLY BOX 396, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist-Chemist, age 33, experienced in milk, fish, edible oils and meat product control, development and research. Wants position in research or development. REPLY BOX 398, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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